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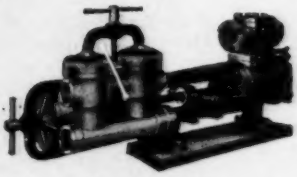

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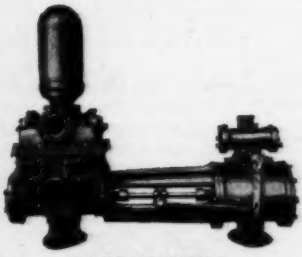

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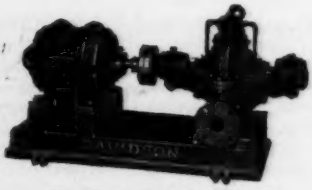

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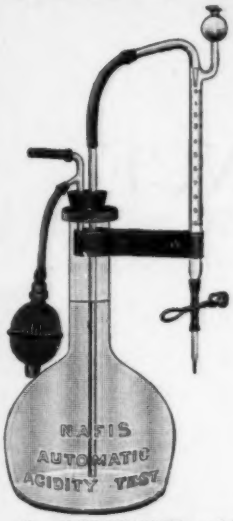

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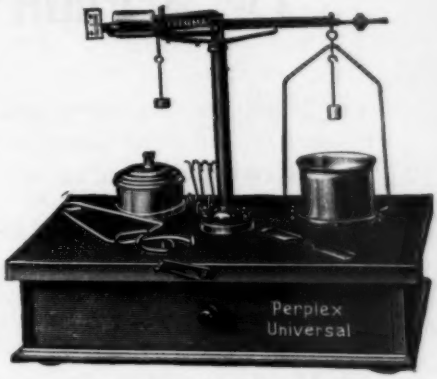

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C. H. ECKLES AND T. W. GULLICKSON

Division of Dairy Husbandry, University of Minnesota, St. Paul, Minnesota

Received for publication February 9, 1924

On farms selling whole milk calf raising is a serious problem. The market value of whole milk under these conditions is usually so high as to practically prohibit feeding it to the calf and feeding skimmilk is likewise impracticable because of the inconvenience of separating the milk and marketing both cream and milk. Farmers under these circumstances instead of raising calves usually depend upon purchasing cows with which to maintain their herds, with the result that herd improvement is at a standstill. That a relatively large number of farmers are represented in this class is indicated by census figures which show that approximately 54 per cent of all the calves born in this country are the offspring of cows the milk of which is sold as whole milk from the farm.

Commercial calf-meals and so-called milk substitutes have been used for calf feeding for a number of years. In general, however, they have been found too expensive and in most cases also they have proved unsatisfactory except when milk feeding has been continued during the first two to four months of the life of the calf.

Methods of raising calves on a limited amount of milk have also been demonstrated at several state experiment stations (1, 2) as has the use of powdered skimmilk and malted milk (3, 4). These methods, however, are relatively expensive and consequently their use in practice will be limited.

Rapid progress has been made in recent years in the development of mechanical means for concentrating buttermilk either into a condensed or powdered form. This has made possible

the utilization of an excellent food product which in the past has been largely wasted. From an insignificant beginning this industry has grown to mammoth proportions. The estimates of the Bureau of Markets (5) for the year 1921 give a total production in the United States of approximately 30,000,000 pounds of condensed or semi-solid, and about 8,000,000 pounds of dried buttermilk. Since then the output of these products has greatly increased, and still only a small percentage of the total amount of available raw product is so utilized.

Why not utilize this concentrated product for calf feeding? The fact that raw buttermilk is practically a waste product in the sections where produced makes its ultimate cost in condensed or powdered form comparatively low. Also the use of ordinary raw buttermilk as a calf feed is not an uncommon practice in certain dairy sections of the world. Hill (6) in his history of the Guernsey breed states that calves on the Isle of Guernsey are fed on the milk from the churn from the time they are but a few days old until able to subsist on coarser feeds. In Ireland, Hanly (7) states that calves are raised successfully on buttermilk. Neither is the practice unknown in this country, as calves on farms located near creameries are sometimes raised on the milk from the churn. The experimental work of Otis (8) also indicated that this practice is successful. In his experiments one lot of 10 calves fed on buttermilk made an average daily gain of 1.79 pounds as compared with 2.02 pounds by a group on skimmilk. He found also that the buttermilk lot had less digestive trouble than the skimmilk lot.

Ordinary raw buttermilk has almost the same percentage composition and feed value as skimmilk. The chief difference is in the higher percentage of acidity which it usually contains. In the process of concentrating it, certain chemical and physical changes take place. These, however, are not of such a nature as to seriously, if at all, decrease the digestibility and food value of the product. It would therefore seem that it should be entirely satisfactory as a calf feed.

EXPERIMENTAL

The object of the experiment reported here was to determine whether calves would make satisfactory growth when fed concentrated buttermilk products in place of skimmilk. The general plan was to rear the calves on condensed or dried buttermilk, properly diluted and fed in the same manner as skimmilk supplemented by a good hay and grain ration. Ten calves in all were used.

In the first experiment two groups were used. The first group consisting of a purebred Jersey male and a grade Guernsey heifer

TABLE 1

Feed consumed to six months of age. Calves raised on semi-solid and powdered buttermilk

NUMBER OF ANIMAL	BREED	AGE AT WEANING	WHOLE MILK FROM FIVE DAYS OF AGE	POWDERED BUTTERMILK	SEMI-SOLID BUTTERMILK	GRAIN	ALFALFA HAY
		days	pounds	pounds	pounds	pounds	pounds
E-7	Pbd. J.	106	250		186	376	262
E-8	G. Gr.	105	250		186	399	278
E-9	G. Gr.	150	268	135.1		363	237
E-10	G. Gr.	150	243	138.7		391	242
E-11	Pbd. J.	150	156	147.7		430	255
E-12	H. Gr.	70	201	65.0		497	500
E-14	H. Gr.	150	176	156.2		406	450
E-15	H. Gr.	70	180	51.7		452	433
E-16	H. Gr.	150	140	154.3		466	414
E-17	H. Gr.	70	146	60.8		464	475

calf was fed the semi-solid or condensed form of the buttermilk to 105 days of age. The second group received powdered buttermilk. In this lot were 2 grade Guernsey heifers and a purebred Jersey bull calf. They were weaned at 150 days of age.

The second experiment was begun after the first had been completed. The object was to secure data from a larger number of animals and to compare the results obtained from early weaning with that of late weaning. Five grade Holstein calves received powdered buttermilk. Three of them were taken off the buttermilk at 70 days of age while the other 2 continued to receive it until they were the age of 150 days.

The semi-solid buttermilk used was purchased from the Fairmont Creamery Company, Sioux City, Iowa. As will be shown by table 2, this product is approximately three times as concentrated as the original buttermilk. It was fed in a diluted form being mixed in the ratio of 1 part buttermilk to 3 parts by weight of warm water. This gave a mixture with practically the same composition as ordinary skimmilk.

Two lots of powdered buttermilk were used. That fed to the Guernsey-Jersey group was obtained from the Fairmont Creamery Company, Sioux City, Iowa. The Holstein group used in the second experiment was fed a product manufactured by the Collis Products Company, St. Paul, Minnesota. The

TABLE 2

Comparison of the semi-solid and powdered buttermilk used

	FRESH BUTTERMILK*	SEMI-SOLID BUTTERMILK	POWDERED BUTTERMILK
	pounds	*pounds*	*pounds*
Total solids	9.4	30.51	92.11
Water	90.6	69.49	7.09
Protein	3.6	11.14	35.00
Fat	0.1	0.84	2.86
Nitrogen free extract	5.0	15.80	43.59
Ash	0.7	2.73	11.46
Calcium		0.449	2.73

* Feeds and Feeding, 18th ed. p. 713.

composition of the products used together with the average analysis of buttermilk for comparison is given in table 2. This table indicates that these products contained about 9 times as high a percentage of solids as common buttermilk. Consequently to give them approximately the same composition as skimmilk 1 part of the powder was dissolved in 9 parts by weight of warm water.

Both the semi-solid and the powdered lots were typical of the product made from buttermilk of the quality common in creameries of the so-called centralizer type where the cream is transported a considerable distance and is ordinarily neutralized before churning. That a neutralizer was used is indicated by the

relatively high calcium content. When computed on the basis of the percentage present in the dry matter the concentrated products contain approximately twice the amount of calcium found in ordinary skimmilk. The addition of lime, however, is not objectional from a nutrition standpoint and may increase rather than decrease the feeding value of these products. However, in case a magnesium compound was used as a neutralizer in the cream the added mineral matter might be detrimental on account of the magnesium calcium antagonism which has been recognized in recent years. It has been shown that an excess of magnesium in the food intake results in the elimination of calcium.

As in the case when calves are to be raised on skimmilk, whole milk feeding was continued during the first ten days to two weeks of their lives or until they appeared sufficiently vigorous to stand a change in their diet. The change from whole milk to buttermilk was always made gradually. The method of feeding both the semi-solid and powdered forms of the buttermilk after the addition of the water was identical to that of skimmilk feeding.

In addition to the buttermilk the calves were given all the alfalfa hay they would eat besides receiving a grain ration consisting of 4 parts by weight of cornmeal, 1 of wheat bran, and 1 of linseed oilmeal. The amount of grain was usually limited not to exceed 5 pounds per day per calf at any time up to six months of age.

The animals were kept in separate pens at night and turned out for exercise in a dry lot during the day. Their growth in weight and height was determined by weights taken at ten day intervals and height measurements every 30 days. The growth of the animals was compared to the normal growth curves for females of the dairy breeds as published by one of the authors (9). These normal growth curves are used in place of check animals in investigations concerning growing dairy animals at this experiment station. Unfortunately no normal growth curves are yet available for the Guernsey breed or for males of any breed. For this reason the comparisons in figure 1 are with the Jersey normal. Since one group consisted of 2 Guernsey females and 1 Jersey male, and the other group of 1 Guernsey female and 1 Jersey

male, the results as shown in the figure give the appearance of being somewhat better than they really were. The results as expressed in figures are given in table 3.

Table 1 gives the age of weaning and the feed consumed up to the age of six months. Figure 1 and 2 show the growth curves for the various groups in their relation to the normal curve. The figures indicate that all the calves made excellent growth

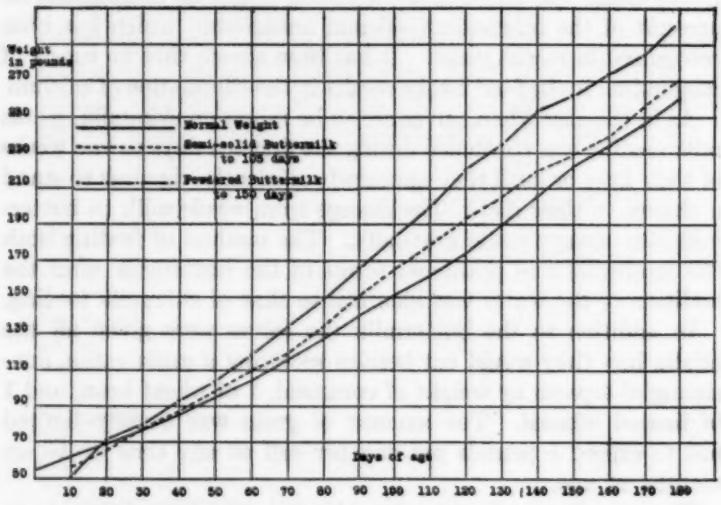

FIG. 1. GROWTH OF CALVES RAISED ON SEMI-SOLID AND POWDERED BUTTERMILK RATIONS COMPARED WITH NORMAL GROWTH

The broken lines represent the average weight by groups. Both groups were above normal during the entire period. The growth of the lot receiving semi-solid buttermilk was below that of the powdered buttermilk lot, partly as the result of earlier weaning.

while on the buttermilk ration. This is especially true of the Jersey-Guernsey group weaned at 150 days of age. That calves weaned at 70 days of age receive a set-back from which they do not entirely recover by the time they are six months old is shown in figure 2. There is, however, not enough difference in weight at six months of age between them and those weaned at 150 days to justify the longer period of buttermilk feeding. Table 3 gives

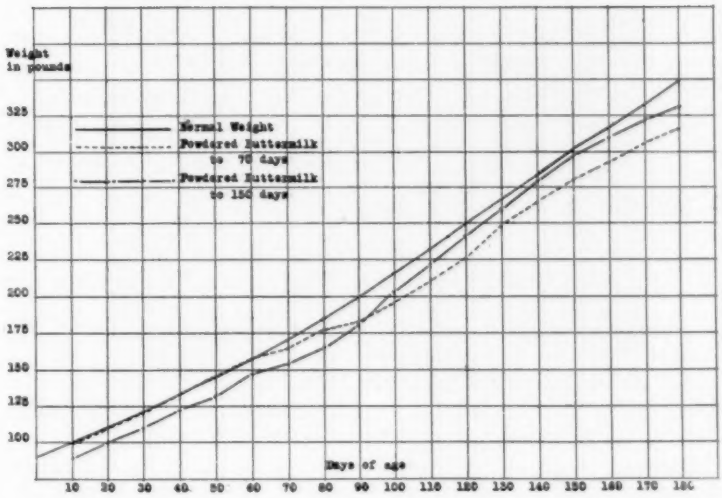

FIG. 2. THE GROWTH OF CALVES RAISED ON POWDERED BUTTERMILK COMPARED WITH NORMAL GROWTH

The broken lines represent the average weight by groups. One group was weaned at the age of 70, the other at 150 days. The earlier weaning resulted in a temporary decrease in the rate of growth. Both groups were slightly below normal at 180 days of age.

TABLE 3

Record of weights. Weights at beginning and close of experiment compared to the normal

NUMBER OF ANIMAL	BREED	WEIGHT AT TEN DAYS OF AGE	WEIGHT AT SIX MONTHS AGE	DAILY GAIN TO SIX MONTHS	NORMAL DAILY GAIN TO SIX MONTHS
		pounds	*pounds*	*pounds*	*pounds*
E-7	Pbd. J.	56	267	1.24	1.16
E-8	Gr. G.	58	275	1.28	1.16
E-9	Gr. G.	64	283	1.29	1.16
E-10	Gr. G.	72	297	1.32	1.16
E-11	Pbd. J.	51	332	1.65	1.16
E-12	Gr. H.	110	327	1.27	1.46
E-14	Gr. H.	80	317	1.39	1.46
E-15	Gr. H.	96	299	1.19	1.46
E-16	Gr. H.	95	344	1.46	1.46
E-17	Gr. H.	92	320	1.34	1.46

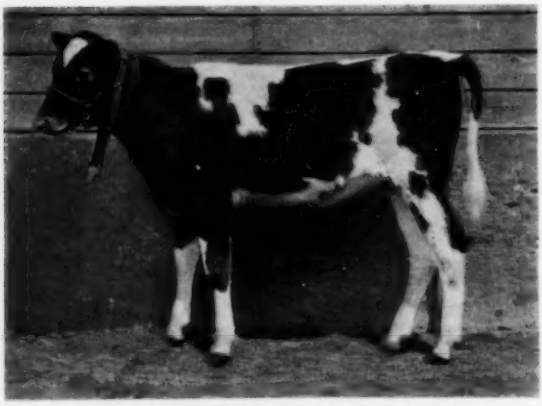

FIG. 3. GRADE GUERNSEY HEIFER. AGE FIVE MONTHS. RECEIVED POWDERED BUTTERMILK UNTIL WEANED AT 150 DAYS OF AGE

Weight at six months 283 pounds. Daily gain to six months 1.31 pounds. Feed consumed up to six months, whole milk 268 pounds, powdered buttermilk 135 pounds, grain 263 pounds, alfalfa hay 237 pounds.

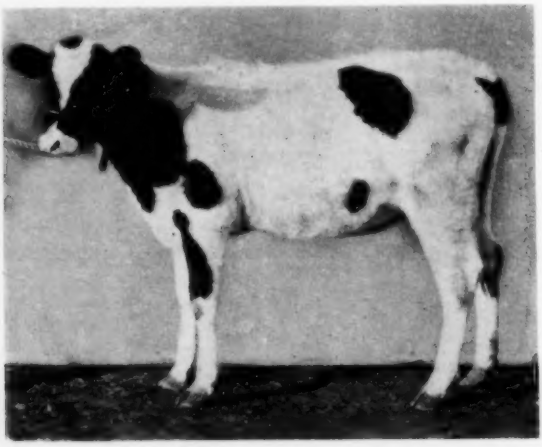

FIG. 4. GRADE HOLSTEIN HEIFER. AGE SIX MONTHS. RECEIVED POWDERED BUTTERMILK TO 70 DAYS OF AGE

Weight at six months 327 pounds, daily gain up to six months 1.27 pounds, normal daily gain to this age 1.46 pounds. Feed consumed to six months, whole milk 201 pounds, powdered buttermilk 65 pounds, grain 497 pounds, alfalfa hay 500 pounds.

the weights of the individual animals at the close of the experiment and the gain per day compared to the normal.

All the calves used in this experiment were unusually free from sickness or digestion troubles. Not one of the calves were ever off feed after getting started on the experiment. No trouble was experienced in getting them to take the buttermilk as prepared. Rather they seemed to prefer it to whole milk. Scours or indigestion was never present. A slightly greater degree of looseness of the bowels was apparent among all the calves during the period of buttermilk feeding than is common when skimmilk is fed. This, however, did not affect their vigor or vitality but rather increased it. The calves were as a whole sleek-coated and thrifty, appearing the equal in size and condition to calves raised on typical farms.

ACKNOWLEDGMENT

A more complete report of the details of the first experiment are found in a thesis for the degree of Master of Science, University of Minnesota, by R. H. Lush who supervised the details of this portion of the investigation.

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A STUDY OF THE BIRTH WEIGHT AND GESTATION OF DAIRY ANIMALS

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The birth weight of a calf is always of interest to breeders. In spite of this fact there is very little definite information available concerning the factors that influence the birth weight of calves. This paper is the result of a study of the calves dropped in the Kansas State Agricultural College dairy herd. This herd is made up of representatives of the four major dairy breeds.

REVIEW OF PREVIOUS WORK

Eckles (1) and McCandlish (2) have recently published articles on this subject in which they have reviewed previous work. Eckles (1) reported upon 433 calf weights obtained from the dairy herd at the University of Missouri over a period of twelve years. He states that breed is the most important factor in influencing the weight of calves at birth and that the male calves average from 5 to 8 per cent heavier than females. His data indicate also that calves from immature cows are smaller than those from mature cows and that cows in advanced age produce smaller calves than cows in the prime of life. His experience prompted the conclusion that the sire had but little influence upon the size of the calf except in the case of cross bred animals when the influence of the sire becomes evident. He states also that the nutrition of the cow during gestation does not influence the size of the calf except under most extreme cases. Eckles found no definite correlation between the gestation period and the size of the calf except in the cases of extremely large or small calves. He presents data for Jersey calves which indicate that the heavier calves are carried longer than the lighter calves.

McCandlish (2) summarized 369 calf weights covering a period of fourteen years in the dairy herd at the Iowa State College. In this herd the male calves averaged 72 pounds which was 10 per cent heavier than the females. The females averaged 65 pounds and all calves 69 pounds. The Holsteins were largest, followed in order by the Ayrshires, Guernseys, and Jerseys. The scrub calves had the lowest average birth weight and the purebreds the highest. The grades used were very nearly the same as the purebreds in weight. McCandlish states that there was an increase in the birth weight of the calves from dams up to five years of age after which age there was an irregular decrease. He also found an increase in birth weight with an increase in the weight of the cows but this was not in direct proportion to the weight of the dam. He found a wide variation in the birth weight of calves dropped between April and October inclusive and the remainder of the year and infers that the calves dropped between April and October may be lighter than others. He further concludes that the gestation period has but little influence on the birth weight of calves.

EXPERIMENTAL WORK

This paper is a summary of data concerning calves dropped in the dairy herd at the Kansas State Agricultural College from September 1, 1910, to January 1, 1922. It has been the practice since September 1, 1910, to weigh all calves within six hours after they were dropped and to weigh the dam of the calf at the same time. The dairy herd is made up of purebred animals from the four major dairy breeds, some grade Holsteins used in the dairy herd and an equal number of grade Holsteins raised under experimental conditions. In the summary given they have been classified as mentioned above.

All calves from gestation periods of less than 260 and more than 295 days duration have been eliminated. The weights of twin calves are not used in the summaries. The weights on all calves have been eliminated that did not have the weight of dam recorded.

DISCUSSION OF BIRTH WEIGHTS

Table 1 is a summary of the data obtained on 521 calves and their dams in the dairy herd at the Kansas State Agricultural College. It will be seen that the average weight of Jersey calves is 57 ± 0.9 pounds, of Guernsey calves 64 ± 0.9 pounds, Ayrshire calves 72 ± 1.03 pounds and of Holstein calves 95 ± 1.57 pounds.

The male calves averaged from 4 to 11 pounds heavier than the females, the average difference for the four breeds being 7.8 per cent. In the case of the Guernsey, Holstein and experimental Holsteins we find the difference between the weights of the bull calves and the heifer calves to be from 3.8 to 4.2 times the probable error which indicates a marked difference between the weights of bulls and heifers in the group studied and would mean the same to be true for other groups under similar conditions.

The relation of the weight of the calf to the weight of the dam followed quite closely the average weight of the breed, but did not increase in proportion to the size of the dams. In the case of the experimental Holsteins we find a marked increase in the relation of the weight of the calf to the dam. This may be due to the method of feeding the animals as will be shown later.

Table 2 is presented for a comparison of the birth weights of the calves at the Missouri, Iowa and Kansas herds. While the results are quite uniform it is important to note that the weights from the Kansas herd are consistently higher than from the other two herds. In most cases, however, the difference in the weights from the Kansas herd is no greater than the difference between the birth weights in the other two herds but they are, with one exception, always higher than the others. It is hard to explain this difference in weight. The weights of the dams of the calves at the Missouri and Iowa stations are not available but in comparing the weights of the Kansas cows with the weights reported by Eckles from all available sources the Kansas cows are larger except for the Guernsey breed. The size of the animals may in a way account for the difference in weights of the calves. The Guernsey herd has been made up of a large proportion of young animals. These heifers, mostly from one sire, have not reached the size desired for the breed.

TABLE 1

Birth weights of calves from Kansas State Agricultural College herd

BREED	MALES		FEMALES		BOTH SEXES		AVERAGE WEIGHT OF DAMS	PER CENT OF WEIGHT OF DAMS
	Number	Weight	Number	Weight	Number	Weight		
		pounds		pounds		pounds	pounds	
Jersey	53	59±1.17	39	54±1.3	92	57±0.90	908±10.2	6.3
Guernsey	50	67±1.18	54	60±1.17	104	64±0.90	948±12.2	6.7
Ayrshire	54	75±1.35	61	69±1.44	115	72±1.03	1033±14.5	6.9
Holstein	34	101±2.12	41	90±1.96	75	95±1.57	1314±22.1	7.1
Grade Holstein	31	91±1.8	38	87±2.09	69	89±1.37	1115±17.1	7.7
Exp. Holstein	31	96±2.15	35	85±1.52	66	90±1.43	1042±18.0	8.6
Weighted average of totals	253	78.5	268	72.8	521	75.5		

TABLE 2

Comparison of weights from three college herds

BREED	MALES			FEMALES			BOTH SEXES			PER CENT OF WEIGHT OF DAMS		
	Missouri	Kansas	Iowa	Missouri	Kansas	Iowa	Missouri	Kansas	Iowa	Missouri	Kansas	Iowa
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Jersey	58	59	55	53	54	52	55	57	54	6.5	6.3	6.1
Holstein	93	101	97	88	90	89	90	95	94	8.0	7.1	7.7
Ayrshire	73	75	68	65	69	65	69	72	66	6.9	6.9	7.8
Guernsey		67	66		60	61		64	64		6.7	7.1

TABLE 3

All available weights of dairy calves

BREED	NUMBER OF CALVES	AVERAGE WEIGHT	DAMS	PER CENT OF WEIGHT OF DAMS
		pounds		
Jersey	418	55	877	6.2
Holstein	513	90	1146	7.8
Ayrshire	230	71	1012	7.0
Guernsey	238	65	965	6.7
Brown Swiss	5	100	1123	8.9
Shorthorn	30	73	1216	6.0
Total all breeds	1434			

Table 3 is a summary of all the available weights of calves for the dairy breeds. The data from the Iowa and Kansas herds is added to that reported by Eckles. The average weights of the calves and the weights of the dams were obtained by finding the weighted average from the data from the different sources. This summary compares quite favorably with the original summary reported by Eckles except in one case. The average weight of Guernsey calves has been reduced from 71 to 65 pounds, and the average weight of the dams from 996 to 965 pounds due to the addition of 104 Guernsey weights from the Kansas herd and 77 from the Iowa herd.

Henry and Morrison (3) report a summary of the weights of calves from the Connecticut, Missouri and Wisconsin stations. Their table includes the results of the Missouri station as does table 3. The results are essentially the same as table 3 with the exception of the weight of Guernsey calves which is 6 pounds heavier than given in table 3.

Eckles has shown that the size and thrift of the calf is, within limits, independent of the feeding of the dam. This has also been observed in practice since it is not uncommon for cows in high condition of flesh to produce small calves and on the other hand thin cows may produce large vigorous calves. These observations are verified by the data presented in table 4 giving the weights of calves and dams of 39 animals used in a feeding experiment from birth through two lactation periods. The animals in one lot were fed alfalfa hay and in another lot alfalfa hay and silage after being taken from milk. The last two lots were fed alfalfa hay, silage and grain, one lot calving at thirty months and the other at twenty-four months of age. The animals in the last two lots received a liberal grain ration. The animals fed alfalfa hay weighed less than the other lots. Their calves were somewhat smaller in weight but were larger in proportion to their dams. Eckles has likewise reported light fed Jerseys and light fed Holsteins whose calves show a much greater proportion to the weights of the dams than animals of the same breeds on full feed.

Maid Henry Pontiac, a purebred Holstein in the Kansas herd, while being fitted for an Advanced Registry test weighed, on six days before freshening, 2150 pounds, this being the limit of weight on the barn scales. After freshening she weighed 1870 pounds and her bull calf weighed 119 pounds which is 6.3 per cent of the weight of the dam. Another case of a cow highly fitted that proved disasterous to both the cow and calf was that of Blossom Mechthilde, a purebred Holstein weighing 1600 pounds bred to a Holstein Bull weighing 2100 pounds that produced a bull calf which weighed 170 pounds within an hour after birth. This is the heaviest calf recorded in this herd. Twin Holstein calves have been recorded in our herd, the total weight of which was 174 pounds and in another case 163 pounds but

TABLE 4

Influence of nutrition of dam upon weight of calves

FEED	NUMBER OF ANIMALS	WEIGHT OF DAM	WEIGHT OF CALF	PER CENT
		pounds	pounds	
Alfalfa hay	12	917	84.8	9.24
Alfalfa-silage	8	966	88.1	9.11
Alfalfa-silage-grain 30	9	1076	90.5	8.4
Alfalfa-silage-grain 24	10	1032	93.2	9.03

the above calf is the heaviest to date. A bull calf weighing 132 pounds was dropped by a cow weighing 1100 pounds, while the cow was on a so-called light fed ration receiving alfalfa hay and silage but no grain and had been on this feed since being weaned. Long time feeding on restricted diets apparently influences the size of a cow's offspring, but feeding influences the size of a calf less than generally believed among breeders.

INFLUENCE OF THE SIRE

The sire is believed by some to influence the birth weight of calves and we frequently hear of a sire that is getting larger or smaller calves than others. In the case of a Holstein sire used in the Kansas herd we have noticed that without regard to the size of the dam the calves sired by Campus Sir Korndyke Quad

have been larger than others.[1] This is shown in table 5. Another difference is noticed in the case of Ayrshire bulls. Cavaliers College Master was a rather large rugged bull and his calves have averaged heavier than the calves from Melrose Good Gift.[1]

Table 5 does not give information that would warrant a very definite conclusion. From the actual weights reported and the observation of the authors it would seem that the ability to sire large calves is an individual characteristic. A Guernsey bull now in use in the Kansas herd is siring calves which to date average heavier than either of the two Guernsey bulls mentioned in the table.

INFLUENCE OF AGE OF DAM ON WEIGHT OF CALF

The age of the dam apparently has an influence upon the size of the calf. The calves from all the cows that have had more than 5 calves were averaged in the order of their birth as shown in table 6. The cows within the different breeds show an increase up to the fifth calf. This increase is not so apparent, however, when all the breeds are averaged. While the data are rather meager they seem to indicate that the first calves are smaller than the calves from the same cows when mature. The size of the calves from individual cows seem to decrease with the age of the cows after the sixth calf. This, however, is not so apparent in the table.

PERIOD OF GESTATION

The influence of the period of gestation upon the birth weight of calves is not marked. In table 7 is presented the data covering the length of gestation for the calves in the college dairy herd. The average weight of the calves and their dams is also given. It will be noted that there is a slight difference in the length of gestation due to breed. The Jerseys have an average gestation period of 284.3 days, the Guernseys 283 days, the Ayrshires 284.6 days and all Holsteins 281.0 days. When a direct average

[1] Not statistically significant.

TABLE 5

Influence of sire on weight of calves

BULL	BREED	WEIGHT OF BULL	NUMBER OF CALVES	AVERAGE WEIGHT OF CALVES
Melrose Good Gift	Ayrshire	1493	49	71 ±1.46
Cavaliers College Master	Ayrshire	1700	21	77 ±2.8
Bells Melrose	Ayrshire	1850	31	72.9±1.3
B. S. Stars and Stripes	Guernsey	1407	8	66 ±4.38
Langwater Benefactor	Guernsey	1400	53	66 ±1.1
Winnies Pogis Torono	Jersey	1289	37	61 ±1.3
Sult. Jolly King	Jersey	1362	35	56 ±1.4
Sir Carlotta P. C.	Holstein	2100	14	95 ±3.06
C. P. F. H. 6th	Holstein	2160	40	95 ±2.2
Campus S. K. Quad	Holstein	2090	23	100 ±3.7

TABLE 6

Relation of age of dam to weight of calf

CALVES	AYRSHIRE	GUERNSEY	JERSEY	HOLSTEIN
	pounds	*pounds*	*pounds*	*pounds*
1st	55	55	55	90
2nd	73	57	62	99
3rd	74	64	57	91
4th	80	61	56	105
5th	85	66	56	96
6th	77	68	58	102
7th	72	67	60	101
8th	64	70	59	93
9th		71	65	
10th		65		

TABLE 7

Length of gestation

BREED	BULL	NUMBER OF CALVES HEIFER	TOTAL	WEIGHT OF DAMS	BULLS	HEIFERS	AVERAGE GESTATION
Jersey	57	43	100	908	285.9±0.95	282.0±1.03	284.3±0.72
Guernsey	50	53	103	948	283.5±0.6	282.5±0.54	283.0±0.46
Ayrshire	52	61	113	1024	284.6±0.71	284.6±0.55	284.6±0.44
Holstein	37	41	78	1319	282.8±0.79	281.8±0.95	282.2±0.62
Grade Holsten	36	38	74	1156	281.2±0.86	280.8±0.89	281.0±0.68
Exp. Holstein	32	36	68	1042	280.6±0.76	280.2±1.12	280.4±0.69

is taken of all the animals the average period of gestation is found to be 282.4 days for all calves with 283.2 days for the bulls and 281.9 days for the heifers. Two gestation periods of 301 days each were recorded. The shortest gestation recorded was

TABLE 8

Relation of weight of calves to gestation period within breeds

CALVES	NUMBER	AVERAGE WEIGHT	AVERAGE GESTATION PERIOD
	Guernsey		
pounds			
40–49	6	45.8	276.8
50–59	22	55	282.3
60–69	45	64	282.3
70–79	23	73	285.1
80–89	6	81.5	285
	Jersey		
40–49	12	45.6	280.5
50–59	42	54.3	285
60–69	31	64.4	283.6
70–79	9	71	288.6
	Ayrshire		
50–59	8	54.6	279
60–69	31	63.9	284.2
70–79	53	74	284.2
80–89	13	83.4	287
90–100	8	93.6	289
	Holstein		
70–79	8	74	280.6
80–89	15	84	279
90–99	16	95	282
100–109	23	104.5	283.6
110–120	11	113	286

of 256 days duration. Fifteen pairs of twins from all four breeds had an average gestation of 273 days. The method of counting the days in the gestation was to add both the day the animal was served and the day the calf was dropped to the actual calendar days covered by the period.

The data in table 7 indicate that there is no very direct correlation between the size of the calf and the period of gestation when divided according to breeds. If there is a relationship it would seem that the smaller breeds carried their calves longer. This, however, is not borne out when the light calves are compared with the heavy calves within the different breeds. As shown in table 8 there seems to be a tendency for the heavier calves to be carried longer by their dams.

TABLE 9

Length of gestation periods for individual cows

	A. Canary Bell	A. Bangora	A. Bangora II	A. Johansa	H. 120	H. 114	J. Owls Design	J. College Tips	J. R. P. II	J. S. J. T.	G. Frances	G. Bessie Countess	G. M. M. Pink	G. B. C. II	J. Rosalpha
	days	*days*	*days*	*days*	*days*	*days*	*days*	*days*	*days*	*days*	*days*	*days*	*days*	*days*	*days*
	289	287	281	289	290	284	281	280	275	284	283	289	285	279	282
	288	281	284	289	281	285	285	283	256	291	277	282	288	288	292
	286	293	283	283	278	280	283	288	258	286	283	282	277	280	291
	276	290	279	285	277	282	288	285	290	301	274	291	286	278	293
	283	285	294	284	286	278	289	282	284	293	278	284	280	287	289
	281		287		280	288	286	292	289		284	284	282	280	
			289		283		287	288						282	
					279										
Average..	284	287	285	286	281	282	285	285	275	291	279	285	283	282	289

The difference in the length of the period of gestation for the different breeds, as shown in table 7 is contrary to results obtained by McCandlish (2) in a study of 360 gestations in the Iowa State College dairy herd. From this study he concludes that breed did not influence the period of gestation. He also states that the average length of gestation for the animals studied was 280 days. This is in accord with Wing (4) but is lower than the average of 1062 observations by Fleming (5) who reports an average gestation of 283 days.

Table 9 gives the length of gestation for 15 cows of the four dairy breeds in the college herd that have produced 5 calves

or more. No effort has been made to summarize the results according to the exact age of the cows but in comparing the different gestation periods it is apparent that there is a wide difference in the individual cows.

The two longest gestation periods observed were 301 days each. Several periods between 290 and 295 days were recorded but there may be some question in regard to the gestation of 301 days. It is not impossible that the 2 animals may have conceived to a later service that was not recorded. Gestations of more than 300 days have been reported previously but they are not common.

SUMMARY

1. The average weight of Jersey calves in the herd studied was 57 pounds, of Guernsey calves 64 pounds, of Ayrshire calves 72 pounds, and of Holstein calves 91 pounds.

2. The Jersey calves represented 6.3 per cent of the weight of their dams, the Guernseys 6.7 per cent, the Ayrshires 6.9 per cent and the Holsteins 7.8 per cent of the weight of their dams.

3. The male calves were 4 to 11 pounds heavier than the female calves. The average birth weight of all bull calves studied is 7.8 per cent heavier than the females.

4. Immature cows produced smaller calves than mature cows.

5. The birth weights recorded for dairy calves in the Kansas herd were consistently higher than the weights of calves reported from the Missouri and Iowa herds.

6. The nutrition of the dam had but little influence on the weight of the calf except in the case of cows on a restricted diet. In the case studied the dams on a restricted diet produced calves heavier in proportion than did well fed dams.

7. A sire may have the ability to influence the birth weight of a calf, but only to a limited degree.

8. The gestation period has no definite influence upon the size of the calf at birth. There are, however, within the different breeds, indications that the large calves are carried slightly longer than the smaller calves.

9. The average length of all the gestations studied was 282.4 days. The bulls were carried 283.2 days and the heifers 281.9. The breeds varied in the length of gestation period as follows:

	days
Jersey	284.3 ±0.72
Guernsey	283.0 ±0.46
Ayrshire	284.6 ±0.44
Holstein	281.0 ±0.15

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THE EFFECT OF HEAT ON THE ACTIVITY OF THE ENZYME PEROXIDASE AS FOUND IN MILK

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The enzyme peroxidase is the most widely distributed enzyme. It is found in all living organisms, both vegetable and animal tissue, and it has been said when a body fails to show the reaction of peroxidase it is dead. One peculiar property possessed by peroxidase is its resistance to decay, one of the most characteristic properties of living matter. It is still an open question whether peroxidase is a true enzyme, a question which cannot be definitely decided until more knowledge is at hand.

It is only by the action of the enzyme that furnish proof of their existence. Their actions can be investigated by studying the chemical nature of the bodies that are formed and also the rate of change and the conditions affecting it. The function of an enzyme is that of a catalyst, accelerating the action which has already begun, but never appearing among the final products. They merely increase the velocity when a chemical system strives to attain its final state. Under the name peroxidases are included those substances which are credited with the ability to accelerate oxidation processes. This action is going on within the organisms between organic peroxides and oxidizable compounds. The properties of peroxidase which concerns this article is the activation of hydrogen peroxide and the transferance of oxygen from the peroxide to other substances such as acid and other phenol derivatives.

The object of the following experiment was (1) to determine to what extent and at what temperature peroxidase as found in milk

[1] Student assistant, 1918.

is destroyed on heating; (2) to study the relation of the monomolecular law, or law of mass action to the rate of inactivation of the enzyme. The effect of heat on the peroxidase has been studied by J. J. Van Eck (Zeit. f. Untersuch der Nahrungsmittel, Band 22, 1911). We deemed it advisable to corroborate his conclusions and extend the application of the effect of heat on peroxidase. Use was made of the well known Storch reaction for heated milk which consists in adding para phenylenediamine

TABLE 1

Comparative scale

SCALE NUMBER	MILK		SCALE NUMBER	MILK	
	Raw	Sterilized		Raw	Sterilized
	cc.	cc.		cc.	cc.
1	0.10	9.90	17	3.50	6.50
2	0.20	9.80	18	3.75	6.25
3	0.30	9.70	19	4.00	6.00
4	0.40	9.60	20	4.25	5.75
5	0.50	9.50	21	4.50	5.50
6	0.75	9.25	22	4.75	5.25
7	1.00	9.00	23	5.00	5.00
8	1.25	8.75	24	5.25	4.75
9	1.50	8.50	25	5.50	4.50
10	1.75	8.25	26	5.75	4.25
11	2.00	8.00	27	6.00	4.00
12	2.25	7.75	28	6.25	3.75
13	2.50	7.50	29	6.50	3.50
14	2.75	7.25	30	6.75	3.25
15	3.00	7.00	31	7.00	3.00
16	3.25	6.75	32	7.50	2.50

and hydrogen peroxide to the milk. If peroxidase is present the enzyme will catalyse the oxidation of the paraphenylenediamine by the peroxide and the deep blue color of the oxidation product will appear. The peroxidase content depends on the degree and length of the heating period and the intensity of the blue depends in turn on the peroxidase content. Inasmuch as the shade of blue varies with the amount of peroxide and para-phenylenediamine the same quantity of these reagents was used in each test. The acidity also affects the rapidity of destruction of the enzyme, therefore, fresh milk was used in all our work.

In order to carry out the experimental work it was necessary to have a method by which the relative amount of peroxidase could be estimated. A comparative scale was made by diluting milk sterilized by heating to 95 to 98°C. for thirty minutes with raw milk in many different proportions.

The determination depending on the fact that the intensity of the blue color varies with the amount of peroxidase present. The same milk was used in the preparation of this comparative scale that was used later in the heating experiment. The dilution for making the comparative scale is shown in table 1.

For the purpose of testing the accuracy of this colorimetric determination, known dilutions were prepared and it was found that a variation of 0.25 to 0.5 cc. of raw milk could be detected. The errors were less in the lower concentrations of peroxides.

The plan of the heating experiment was to heat a sample of raw milk at a constant temperature taking samples at intervals and determining the peroxidase content by adding reagents and referring to the comparative scale. In this way data were secured for studying the rapidity of destruction of the enzyme.

APPARATUS, EXPERIMENTAL WORK AND RESULTS

The flask in which the milk was placed consisted of a wide mouthed bottle provided with a three-holed rubber stopper in which was placed a thistle tube for drawing off samples, a stirring rod for agitating the milk and a thermometer. In carrying out the experiment a constant temperature bath provided with a thermostat was used. The empty flask was placed in the bath until temperature was constant. Then the sample of milk was heated as rapidly as possible to a temperature 2° higher than that at which the experiment was to be conducted by pouring it into a thin flask immersed in boiling water or by carefully heating over a gas burner. The sample was then quickly transferred to the milk flask in the waterbath and about five minutes allowed for the temperature to become constant. Then the samples were drawn off at intervals and tests made with the results indicated in table 2. The hot samples coming from the milk flask was run into a test tube standing in ice cold water, thus stopping the destruction

almost immediately. The color tests were applied by adding 5 drops of a freshly prepared 2 per cent solution of paraphenylendiamine and 5 drops of a neutral 1 per cent solution of hydrogen peroxide to the milk samples, allowing them to stand thirty minutes before making comparison of colors. There is a gradual darkening of color after thirty minutes; so in order to offset this, the tests were applied to the heated samples and to the comparative scale at the same time. The temperature of the heated milk was taken immediately before the sample was withdrawn.

TABLE 2

Heating experiment

NUMBER	TEMPERATURE (NO. 1)	TIME	COLOR NUMBER	ENZYME CONCENTRATION
	°C.	*minutes*		
	70.3	0		
1	70.0	15	25	5.50
2	69.8	5	22–23	4.87
3	69.9	5	21–22	4.62
4	69.9	5	19	4.00
5	70.0	5	16	3.25
6	69.7	7	15	3.00
7	70.2	8	13–14	2.62
8	70.0	5	10–11	1.87
9	69.4	19	8	1.25

Taking the quantity of peroxidase in the raw milk as 10. The value 10 for the initial concentration is only relative and was chosen for convenience in the calculation. The volume of each sample of milk was 10 cc. It is seen from the results in table 2 that the per cent of peroxidase remaining active after heating the milk to 70°C. and holding at that temperature for five minutes was 55 per cent and the concentration decreased gradually on continuing the heating at approximately 70°C.

It was found that when the observed values of the quantity of peroxidase active at different intervals were plotted against time a curve was obtained similar to a logarithmic curve. It is well known from physical chemistry that the action of a true catalyst proceeds according to a definite law. This law is ful-

filled to a varying extent by enzymes, and this is the law of mass action. If a single type of molecules suffer on account of the action, the reaction may be stated by the following expression (1) $\log \frac{1}{t} \frac{E}{E-X} = K$, known as the monomolecular law, in which E represents the original concentration; X the quantity changed; t the time interval expressed in minutes from the beginning of the experiment; K is the velocity constant or reaction constant. Its value is retained no matter how far the reaction proceeds or what the original concentration may have been.

It may be desirable to construct a complete curve from the beginning of the destruction to the time of the last sample being taken. It is, therefore, necessary to know the time which would be required to bring the concentration of peroxidase down to that found at the time of first sampling and at the temperature at which the experiment was conducted. If it were possible to heat every particle instantaneously to the temperature of the experiment we could construct a continuous curve beginning with the initial concentration. This is impossible. If we make use of an average value of K it is possible to obtain a value for T or the time it would have taken to bring the concentration from the beginning to the time t if held at the temperature of the experiment. From the following mathematical expression derived from equation (1) by substituting the value of E, X, t and K we can arrive at a value for T (2). $T = \frac{\log 10 - \log (10-X)}{K} - t.$

The value for T gives the time it would have required to reduce the peroxidase concentration from the initial concentration 10 to the concentration at the time when samples were taken at the temperature at which the milk was held. $T + t$ therefore gives the time required to reduce the peroxidase during the heating experiment after being heated in bath for a time t.

Table 3 gives the calculated value of the velocity constant K and the time T, also the calculated concentration from the average value of K and the average value of T.

The results of experiments conducted at different temperatures are embodied in tables 3, 4, 5, 6 and 7.

TABLE 3

Average temperature 69.9

TUBE NUMBER	TIME	ENZYME CONCENTRATION	K	T	CALCULATED CONCENTRATION
1	0	5.50		25.9	5.50
2	15	4.87	0.0243	26.1	4.91
3	5	4.62	0.0174	23.4	4.38
4	5	4.00	0.0212	24.7	3.90
5	5	3.25	0.0263	28.7	3.47
6	7	3.00	0.0225	25.2	2.96
7	8	2.62	0.0212	23.0	2.46
8	5	1.87	0.0269	32.5	2.19
9	19	1.25	0.0251	31.0	1.42
Average			0.023	26.0	

TABLE 4

Temperature 69.6°C.

TUBE NUMBER	TIME	ENZYME CONCENTRATION	K	T'	CALCULATED CONCENTRATION
1		2.70		66.8	2.71
2	5	2.45	0.0194	66.7	2.45
3	5	2.25	0.0182	66.2	2.23
4	5	2.00	0.0200	67.1	2.02
5	6	1.70	0.0220	69.5	1.79
6	5	1.55	0.0213	69.2	1.63
7	5	1.50	0.0189	65.8	1.48
8	5	1.40	0.0182	64.2	1.34
9	5	1.25	0.0188	64.9	1.26
Average			0.020	67.0	

TABLE 5

Temperature 72.4°C.

TUBE NUMBER	TIME	ENZYME CONCENTRATION	K	T'	CALCULATED CONCENTRATION
1		4.20		7.32	3.92
2	6	2.30	0.1004	7.40	2.17
3	5	1.00	0.1305	8.4	1.11
4	10	0.30	0.125	8.6	0.35
Average			0.12	8.0	

The curves represented in figure 1 show the rate of destruction of peroxidase on heating at a constant temperature and are plotted from the calculated values of enzyme concentration as

TABLE 6

Temperature 71.0°C.

TUBE NUMBER	TIME	ENZYME CONCENTRATION	K	T'	CALCULATED CONCENTRATION
1		7.00		7.8	6.93
2	10	4.75	0.0388	6.2	4.37
3	6	3.75	0.0390	5.3	3.32
4	4	2.50	0.0515	10.2	2.75
5	5	2.12	0.0478	8.7	2.19
6	5	1.87	0.0437	6.4	1.74
7	5	1.62	0.0418	3.6	1.44
8	5	1.12	0.0458	7.7	1.15
9	5	0.70	0.0510	12.8	0.87
10	5	0.62	0.0485	10.5	0.70
11	5	0.55	0.0463	8.0	0.55
12	5	0.42	0.0469	9.0	0.44
13	5	0.35	0.0461	7.8	0.35
Average			0.046	8.0	

TABLE 7

Temperature 70.8°C.

TUBE NUMBER	TIME	ENZYME CONCENTRATION	K	T	CALCULATED CONCENTRATION
3		5.50		14.9	5.07
4	5	4.75	0.0293	13.6	4.15
5	5	4.25	0.0258	11.4	3.40
6	5	3.25	0.0351	13.1	2.78
7	5	2.25	0.0447	17.3	2.28
8	5	1.75	0.0458	18.6	1.86
9	5	1.25	0.0493	22.0	1.5
10	5	0.75	0.0570	29.8	1.25
Average			0.04	17.0	

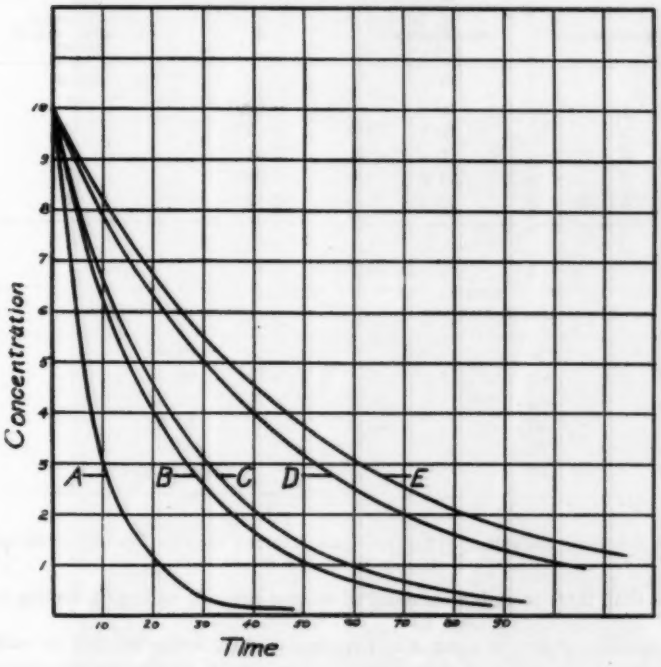
reported in the tables, 3, 4, 5, 6 and 7. It will be noticed that the experimental error in these observations in practically all cases is well within 0.2 to 0.3 cc. of active enzyme solution.

In addition to the foregoing tables the results of experiments at various temperatures is of interest when comparing the values of K and the destruction of peroxidase obtained for the different temperatures of heating the milk.

Fig I

Rate of Destruction of Peroxidase on Heating

A Temperature 72.4° C Temperature 70.8° E Temperature 69.6°
B " 71.0° D " 69.9°



The results as shown in table 8 indicate some practical application of these experiments. They express mathematically the relation between (1) period of heating, (2) degree of heating, (3) diminishing the activity.

The conclusion drawn from the data in the tables is valuable in studying the effect of pasteurization at different temperatures. It was found that when milk was heated to 62.5°C and held for twenty minutes produced no apparent effect on the peroxidase. In order to test the effect of flash pasteurization, a laboratory apparatus (fig. 2) was contrived by which the milk was heated to the required temperature and cooled in less than three seconds.

The results shown in table 9 were obtained.

TABLE 8

EXPERIMENT NUMBER	TEMPERATURE	K	TIME REQUIRED TO DESTROY HALF OF ENZYME
	°C.		*minutes*
1	69.6	0.020	35
2	69.9	0.023	30
3	70.8	0.04	17
4	71.0	0.046	15
5	72.4	0.120	6

TABLE 9

HIGHEST TEMPERATURE	PEROXIDASE DESTROYED
°C.	*per cent*
85	92.5
85	92.5
80	42.5
76	40.0
64	Very slight

FIG. 2. APPARATUS USED IN HEATING MILK RAPIDLY TO THE TEMPERATURE AS SHOWN IN TABLE 9

Less than three seconds were required to heat the milk and again cooling to 30°C.

Explanation of parts of apparatus: 1 shows a 2000-cc. beaker holding the milk to be heated. The milk is syphoned into the condensor *2*, the flow regulated by a clamp. Steam under 10-pound pressure was passed through the condensor. The heated milk flowing over the thermometer *5* then passing through a short condensor *3*. The cooling was effected by passing under cooled salt-brine through this condensor. A 2-gallon candy bucket *4* contained the under-cooled brine. The heating of the milk was controlled by the rate of flow of milk through *2* and also by regulating the flow of steam.

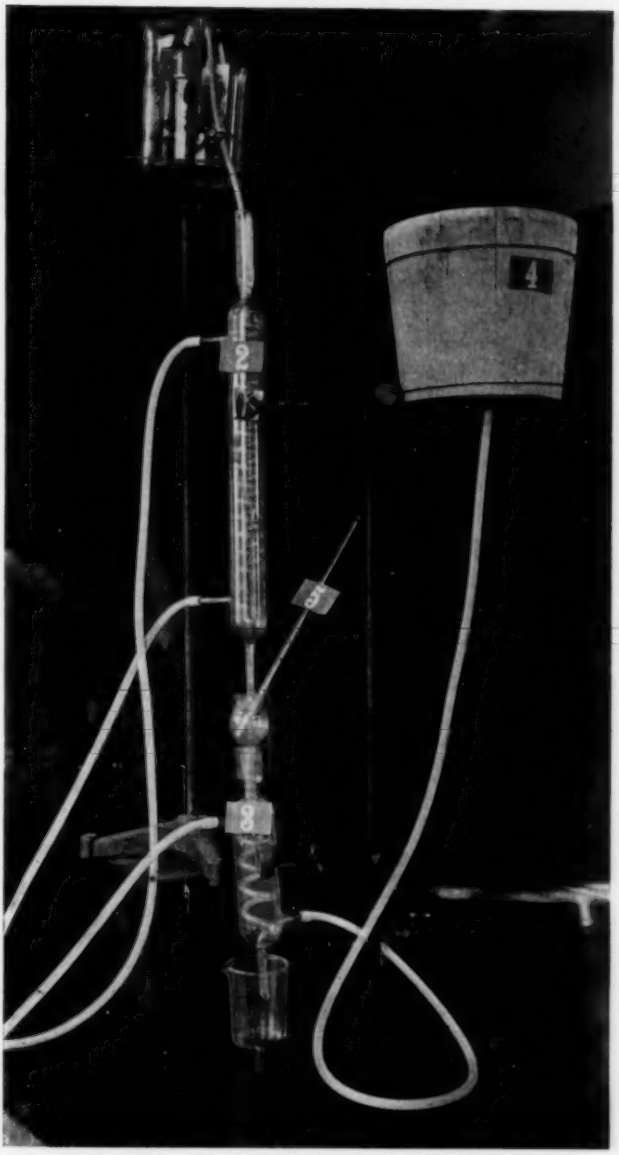


FIG. 2

This work shows that where the regular flash pasteurization temperature of 85°C. is reached, the greater part of the peroxidase is inactivated.

Since inactivation by heat occurs with all enzymes and since this action is thought to be due to an alteration in their general colloidal condition, a condition in which, it is assumed, all enzymes exist, from the foregoing satisfactory agreement of the observed value and those calculated it is to be seen that the rate of inactivation of the enzyme peroxidase on heating follows a definite law. The rate of inactivation is a function of the temperature and time of exposure. It was found that if milk was heated to 62.5°C and held at that temperature for twenty minutes had little effect on the peroxidase. Our results are in close agreement with the findings of Enler and Pape, who heated the juice of fresh horse radish to 60°C. for two hours and found that the activitty of the peroxidase diminished only in the proportion of 7 to 5. We can, therefore, reasonably conclude that the optimal temperature is in the neighborhood of 60°C. and the maximal temperature at which the peroxidase is completely inactivated at 80 to 85°C. For most enzymes the optimal temperature is stated to be between 40 to 55°C. and the maximal temperature to be between 65 to 75°C. It is well known that a rise in temperature causes an increased activity of the enzymes, however, the point where inactivation begins the speed of reaction is retarded. As the temperature is increased the destruction increases more rapidly than the increase in the effect of heat on the acceleration of enzyme action, when the curve begins to drop, and at the maximal temperature the curve ceases to exist. This is true of all enzyme actions. Unfortunately very few enzymes can be studied as critically as the oxidases and peroxidases. From what is known concerning the enzymic action we can briefly state that all enzymes are inactivated at about the same temperature and all enzymes are colloidal and the paralysis by heat seems to be due to an alteration of the colloidal condition, hence, we should expect the same amount of heat to produce a similar effect on all enzymes.

THE INFLUENCE OF CERTAIN FACTORS ON THE HYDROGEN ION CONCENTRATION OF MILK

II. TEMPERATURE CHANGES

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In connection with the acidity studies as effected by feeding (1), it seemed desirable to study the effect of temperature changes. Hence, the following studies were made on milk from the same cows as were used in the other experiments.

The samples (100 cc.), were titrated at room temperature then at higher temperatures, the heating being done by partially immersing a flask containing the sample in hot water and shaking until the milk assumed a temperature near that desired and quickly titrating with 0.1 N NaOH, using phenolphthalein as an indicator.

The pH determinations at increased temperatures were made on the same samples as were used for the primary H^+ ion studies. These samples were warmed by immersing the hydrogen electrode vessel in the water bath and when the desired temperature was reached, the determinations were made as soon as possible, about five minutes being required to bring the electrode to equilibrium. The temperature was taken at the time the determinations were actually made, with both the H^+ ion and total acidity determinations.

From a study of tables 1 and 2 it can be seen that both the H^+ ion concentration (pH) and the total (titratible) acidity of milk increase upon heating, which is contrary to what Van Dam (2) found.

The effect of temperature on the acidity of milk was so marked that it seemed desirable to make further studies on the effect of

TABLE 1

Effect of increase in temperature on the pH value of fresh cow's milk

DATE	COW NUMBER	TEMPERATURE AND pH RANGES					
3/20/22	43	Temperature	17°	25°			
		pH	6.06	5.98			
3/21/22	43	Temperature	20°	44°	49°		
		pH	6.04	5.89	5.80		
3/22/22	43	Temperature	19°	32°	35°	50°	
		pH	6.17	6.15	6.12	5.89	
3/20/22	229	Temperature	18.5°	41°			
		pH	6.32	6.05			
3/21/22	229	Temperature	22°	37°	47°		
		pH	6.30	6.18	6.06		
3/20/22	297	Temperature	20°	35°	40°	43°	
		pH	6.24	6.09	6.00	5.93	
3/21/22	297	Temperature	20°	56°			
		pH	6.23	5.49			
3/22/22	297	Temperature	19°	43°	58°		
		pH	6.10	6.08	5.87		

TABLE 2

Effect of increase in temperature on the total acidity of cow's milk

DATE	COW NUMBER	TEMPERATURE AND ACIDITY RANGE					
3/20/22	43	Temperature	21°	39°	55°	73°	80°
		cc. NaOH	23.30	24.40	25.80	26.46	27.76
3/21/22	43	Temperature	21°	48°	65.5°	72°	
		cc. NaOH	31.70	33.73	37.70	42.33	
3/21/22	229	Temperature	22°	48°	65°	75°	
		cc. NaOH	31.45	37.70	40.55	43.75	
3/20/22	297	Temperature	20°	45°	70°	84°	
		cc. NaOH	22.90	24.50	26.45	28.30	
3/21/22	297	Temperature	20°	43°	71°	77°	80°
		cc. NaOH	25.60	28.75	30.85	33.75	36.45
3/22/22	297	Temperature	19°	32°	40°	52°	60°
		cc. NaOH	26.90	28.90	30.56	32.25	33.96
3/22/22	297	Temperature	70°	80°			
		cc. NaOH	35.30	38.64			

temperature changes on the total acidity of milk, using both the old method and the new method of Van Slyke and Bosworth (3). (See table 3.)

TABLE 3

Effect of increase in temperature on the total acidity of cow's milk

SAMPLE NUMBER	TEMPERATURE AND ACIDITY RANGE						
I. Old method. Heated with NaOH in milk from previous titrations							
1a	Temperature	17.5°	31.0°	52.0°	68.0°	80.0°	
	cc. NaOH	20.70	21.80	23.52	24.21	25.13	
2a	Temperature	21.0°	46.0°	64.0°	75.0°	80.0°	
	cc. NaOH	21.68	22.80	24.32	25.52	27.70	
II. Van Slyke and Bosworth's New Method, but milk heated as in I							
1a	Temperature	17.5°	32.0	52.0°	Spilled at this point		
	cc. NaOH	7.20	7.70	8.88			
2a	Temperature	19.5°	35.0°	54.0°	70.0°	80.0°	
	cc. NaOH	7.74	8.46	9.60	12.88	15.86	
3a	Temperature	20.0°	35.0°	52.0°	68.0°	78.0°	82.0°
	cc. NaOH	8.00	8.26	8.80	11.22	14.40	16.10
III. Old method. Milk heated in absence of alkali							
1b	Temperature	21.0°	37.0°		57.0°	65.5°	
	cc. NaOH	21.00	21.30		22.70	22.98	
2b	Temperature	22.0°	40.0°	53.0°	69.0°		
	cc. NaOH	20.80	22.16	22.60	23.10		
IV. New method. Milk heated in absence of alkali							
1b	Temperature	21.0°	37.0°	61.0°	66.0°	71.0°	
	cc. NaOH	7.50	7.60	8.58	9.02	9.70	
2b	Temperature	21.0°	42.0°	64.0°	72.0°	75.0°	
	cc. NaOH	7.50	7.80	9.08	9.80	10.08	

Both methods were used under the two conditions mentioned below. Under the first set of conditions the sample from the first titration was warmed for the second titration and after being neutralized by the second titration was again warmed for

the third, and so on for the complete series of titrations on that particular sample. Thus a neutral sample was warmed each time for the succeeding titration.

In the second set of conditions, fresh samples were warmed each time for each succeeding titration.

From table 3 it can be seen that the presence of alkali in the sample when it is heated causes an extra increase in the acidity. When the temperature reaches about 80°C. a brown color develops and a rapid increase in acidity takes place. This is likely due to some lactose being oxidized by the alkali. Only a slight color develops when a sample is heated to 80° in absence of alkali. The effect of the alkali is shown much more when the method of Van Slyke and Bosworth is used.

CONCLUSIONS

The effect of increased temperatures on the hydrogen ion concentration and total acidity of milk was studied. Two methods for total acidity were compared. An increase in temperature caused an increase in both total acidity and acidity as pH value, whether samples previously neutralized or fresh samples were used for the determinations.

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THE RATE OF MILK SECRETION AS AFFECTED BY AN ACCUMULATION OF MILK IN THE MAMMARY GLAND

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Many investigations have shown that the milk of all mammals is a true sectetion. The experimental work on the precursors of the various constituents of milk has been summarized by Meigs (1) and need not be repeated here. If milk is a true secretion, then it seems reasonable to expect that the rate of secretion would follow an orderly course governed by some law of nature. As the transformation of the precursors of milk to the various normal constituents of milk are chemical in nature, the rate of change or the rate of secretion might reasonably be expected to follow the rate of change of certain chemical reactions.

Assuming that milk secretion is chemical in nature, it, like other chemical reactions, is governed by the law of mass action. In other words, the rate of milk secretion is dependent upon the active mass of the precursors of milk in the blood and on the removal of the products of the reaction. In addition, certain harmones or internal secretions may act as an activator or catalyzer.

The object of this paper is to show the effect of an accumulation of milk in the udder on the rate of milk secretion. Kaull (2), in Germany found that when cows were milked at various intervals up to twelve hours the rate of milk secretion was very materially influenced by the period between milkings. Practical dairymen (3) have also observed the advantages of frequent milking.

PLAN OF INVESTIGATION

In this investigation 4 dairy cows (2 Jerseys and 2 Ayrshires) were milked during an experimental period of about three months. This period was divided into alternate three day experimental and three day rest periods. The cows were milked at 5:00 a.m. and 5:00 p.m. daily with the exceptions mentioned in the following paragraph.

TABLE 1

The effect of the interval between milkings on the rate of secretion and composition of milk

HOURS AFTER PRECEDING MILKING	MILK	FAT	FAT	SPECIFIC GRAVITY	SOLIDS
	pounds	*per cent*	*pounds*		*per cent*
1	1.05	7.56	0.084		
2	1.51	7.76	0.123		
3	2.61	6.94	0.185	1.0302	15.60
4	3.14	6.34	0.200	1.0304	15.38
5	4.28	6.01	0.267	1.0289	15.15
6	4.29	5.94	0.268	1.0292	16.19
7	5.71	5.35	0.322	1.0278	14.87
8	6.39	5.16	0.332	1.0291	14.39
9	6.63	5.37	0.372	1.0280	14.45
10	8.12	4.86	0.418	1.0286	13.91
11	8.96	4.73	0.438	1.0281	13.87
12	8.70	4.63	0.403		
13	10.22	4.15	0.456	1.0284	13.02
14	9.95	3.88	0.404	1.0290	12.70
16	10.60	3.75	0.422	1.0289	
18	11.60	4.24	0.535		
20	12.70	4.13	0.571		
24	13.40	4.59	0.659	1.0304	13.90
28	14.70	4.63	0.759		
32	15.40	3.59	0.597		11.51
36	14.60	3.80	0.685		12.33

During the first three day experimental period an additional milking was made at 6:00 a.m.—one hour after the preceding (5:00 a.m.) milking. In this way the milk secreted during the "first hour" was obtained. During the second three day experimental period the additional milking was made at 7:00 a.m., or two hours after the previous milking. This gave the milk secreted during a two hour period. When the lapse of time after

the last (5:00 a.m.) milking exceeded twelve hours the 5:00 p.m. milking was omitted and when the time exceeded twenty-four hours the following 5:00 a.m. milking was also omitted. In this way the milk secreted at intervals ranging from one to thirty-six hours was secured.

RESULTS OF INVESTIGATION

The averaged data for the 4 cows is shown in figure 1. It will be seen that the greater the amount of milk accumulated in the udder, or the longer the interval between milkings, the less the speed of milk secretion in unit time. This curve has the same shape as the curves representing the rate of change of a reaction in chemistry when the products of the reaction are not removed. This would indicate that milk secretion is indeed a chemical process and follows the usual laws of chemical reactions.

It should be pointed out that there is an error involved in the method of securing the data due to the advance of the stage of lactation in the three month period covered by the investigation. The advance of the stage of lactation and the experimental procedure actually decreased the production of milk to an average of 73 per cent of that produced at the start of the work. Thus the milk secreted toward the end of the experimental period, or for the longer time intervals, may have been slightly less than it would have been had it been possible to conduct the entire investigation at the same time.

The declining curve in figure 1 represents the milk secreted per hour at successive intervals and shows very clearly the effect of the accumulation of milk in the udder on the rate at which milk was secreted. In fact there is a definite rate at which the accumulation of milk inhibits further secretion. Considering the production of milk during the first hour as 100 per cent the rate of the secretion of milk during each succeeding hour is approximately 95 per cent of that of the preceding hour.

This data also throws light on the practical question of the value of milking cows three or four times daily. By referring again to figure 1 it will be noted that during a six-hour period 5 pounds of

milk was secreted, during an eight-hour period 6.3 pounds of milk, and during a twelve-hour period, 8.6 pounds of milk. On a twenty-four hour basis the production of milk during these periods would be as follows:

Two times per day = 8.6 × 2 = 17.2 pounds
Three times per day = 6.3 × 3 = 18.9 pounds
Four times per day = 5.0 × 4 = 20.0 pounds

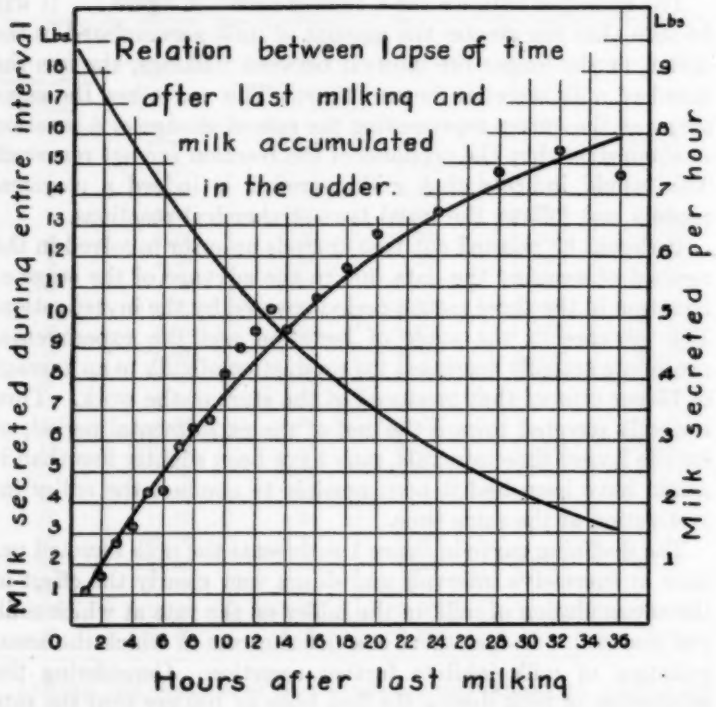
Relation between lapse of time after last milking and milk accumulated in the udder.
Milk secreted during entire interval
Lbs
Milk secreted per hour
Lbs
Hours after last milking
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36

FIG. 1. THE RISING CURVE REPRESENTS THE TOTAL MILK OBTAINED AT THE END OF THE TIME INTERVAL SHOWN IN THE ABSCISSAE

The declining curve represents the milk secreted per hour at successive intervals. Each hour's milk production is shown to be 95 per cent of the production for the preceding hour.

On a percentage basis, considering the production of the cows milk twice daily as 100 per cent, the cows milked three times per day produce 110 per cent, and those milked four times per day

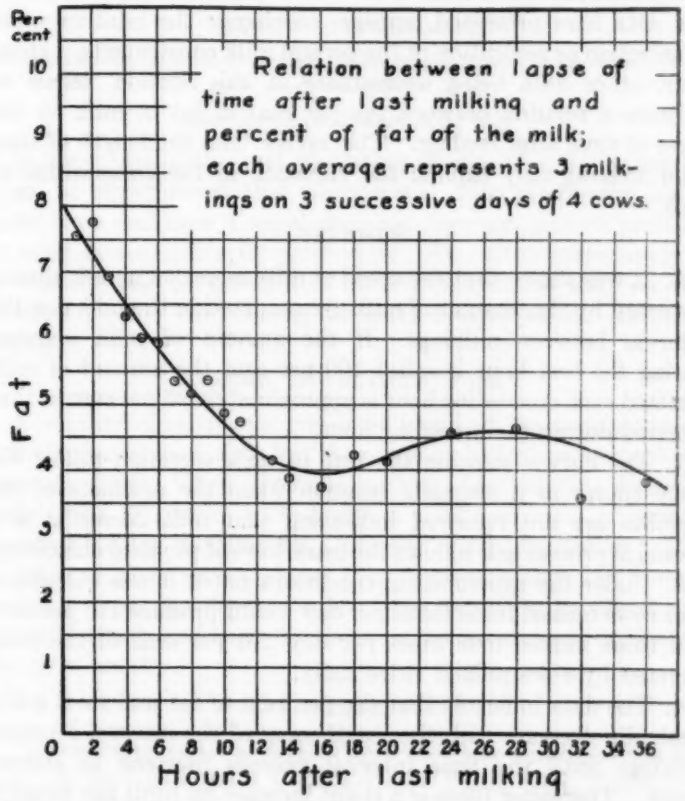
Per cent
Relation between lapse of time after last milking and percent of fat of the milk; each average represents 3 milkings on 3 successive days of 4 cows.
Fat
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
Hours after last milking

FIG. 2. THE CURVE SHOWS A GRADUAL DECREASE IN THE PER CENT OF FAT IN THE MILK AT VARYING TIME INTERVALS FOLLOWING THE PRECEDING MILKING

116 per cent. It should be noted that this data is based on Jersey and Ayrshire cows averaging less than 20 pounds of milk daily.

The effect of the length of the period between milkings on the composition of the milk is shown in figure 2. The per cent of fat gradually decreases as the interval between milkings increases. The accumulation of milk or the "back pressure" produced from the data here presented, appears to change the relative speed of secretion or resorption of the several milk constituents. However, other data being accumulate at this station seems to indicate a relation between the per cent of fat in milk on the lapse of time after feeding. This rather than the length of time after milking may explain the variation in the composition of milk.

SUMMARY

1. It was shown that the speed of milk secretion in unit time is governed by the amount of milk accumulated in the udder or the interval between milkings. If the amount of milk secreted during the first hour is called 100 per cent the amount of milk secreted each succeeding hour is approximately 95 per cent of that secreted during the preceding hour.

2. The curves showing the rate of milk secretion follow the same course as a chemical reaction when the products of the reaction are not removed indicating that milk secretion is a chemical process and follows the usual laws of physical chemistry.

3. Under the experimental conditions noted it was calculated that cows milked three times per day would produce 110 per cent and those milked four times per day 116 per cent of the milk secreted by cows milked twice daily.

4. The data indicates that the per cent of fat and total solids gradually decrease with the lengthening of the interval between milkings until the time interval exceeds fourteen to sixteen hours. Thereafter there is a slight increase up until the twenty-fourth to twenty-sixth hour, followed again by a gradual decline until the thirty-sixth hour.

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THE INFLUENCE OF THE STAGE OF LACTATION ON THE PRODUCTION OF DAIRY COWS

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In determining the real producing ability of a dairy cow it must be remembered that phenomenal milk production for a short time and then a rapid decrease does not lead to greatest or most economical milk production. Too often persistency of production has been forgotten and emphasis laid only on the production of a cow during the early portion of her lactation period.

RÉSUMÉ OF PREVIOUS WORK

A number of references are to be found on the production of cows for but a short time but these will be looked on as inapt for insertion here. Three separate workers, Linfield (2), Woll (3) and Grady (1), have worked with a combined total of several hundred cows of the Holstein, Guernsey and Jersey breeds. The average of their results shows that there is a slow but steady decrease from the first month of the lactation to about the seventh month and then the decrease becomes more rapid until the cows are dry.

DATA PRESENTED

The entire material presented here has been collected from the herd on the Iowa State College Dairy Farm, from December, 1907, to December, 1921. All normal lactations have been considered and a normal lactation has been looked on as not exceeding in duration 12 consecutive periods of 30 days each. Where a lactation exceeded 360 days the extra days were thrown off, but if the cow dried off naturally before the expiration of 360 days, the lactation was included as normal for the cow at that time.

The greater portion of the data has been obtained from the purebred herd but additional records were obtained from an experimental herd of scrub cows and the two generations out of them and by purebred bulls which have already completed records. On the whole 428 lactations of 162 cows have been used. No correction for age or other factors has been made.

The average production of the Ayrshire, Guernsey, Holstein and Jersey breeds have been tabulated separately by months and in a similar tabulation are included the scrubs, first grades, second grades and all the purebreds for comparative purposes.

TABLE 1

Summary of data used

BREED	NUMBER OF COWS	NUMBER OF LACTATIONS
Ayrshire	12	29
Guernsey	26	81
Holstein	30	82
Jersey	40	108
All purebreds	116	300
Scrubs	14	57
First grades	14	38
Second grades	16	33
All scrubs and grades	46	128
Total	162	428

From these it is evident that there is a general decrease in milk and fat production from the first to the last month of the lactation, although in the cases of the Ayrshires and Holsteins the highest level of milk production is reached in the second period. When all the purebreds are grouped together this is also found to be true.

In the percentage of fat in the milk the Jerseys show a gradual rise from the beginning to the end of the lactation period, while the Guernseys show a drop in the second month only and then the percentage of fat rises until the end of the lactation. In the case of each of these breeds the average fat percentage for the

TABLE 2

Average production of purebreds by breeds

MONTH	AYRSHIRE			GUERNSEY			HOLSTEIN			JERSEY		
	Milk yield	Fat yield	Fat content	Milk yield	Fat yield	Fat content	Milk yield	Fat yield	Fat content	Milk yield	Fat yield	Fat content
	pounds	pounds	per cent	pounds	pounds	per cent	pounds	pounds	per cent	pounds	pounds	per cent
1	951.5	40.58	4.26	831.8	38.23	4.60	1353.7	49.27	3.64	769.4	35.97	4.67
2	992.0	37.76	3.81	822.8	36.58	4.45	1401.3	46.36	3.31	755.8	35.52	4.70
3	923.5	34.85	3.77	749.2	33.82	4.51	1302.1	41.91	3.22	693.3	32.93	4.75
4	831.9	31.34	3.77	669.2	30.84	4.61	1192.5	39.08	3.28	626.3	30.68	4.90
5	752.5	28.94	3.85	601.1	28.41	4.73	1073.6	35.01	3.26	573.7	28.70	5.00
6	703.7	27.40	3.89	559.7	26.59	4.75	984.9	32.64	3.31	516.8	26.33	5.09
7	654.9	25.50	3.89	515.6	24.74	4.80	912.5	30.47	3.34	475.3	24.39	5.13
8	603.7	23.59	3.91	461.4	22.77	4.93	850.2	28.87	3.40	433.5	22.29	5.14
9	546.3	21.48	3.93	410.2	20.64	5.03	766.7	26.21	3.42	380.5	19.94	5.24
10	436.8	17.79	4.07	346.4	17.51	5.05	665.8	22.88	3.44	330.7	17.59	5.32
11	312.3	13.12	4.20	285.8	14.83	5.19	583.6	20.53	3.52	272.2	14.61	5.37
12	222.9	9.47	4.25	242.3	12.72	5.25	474.7	17.09	3.60	224.8	12.07	5.37
Year..	7932.0	311.82	3.93	6495.5	307.68	4.74	11561.6	390.32	3.38	6052.3	301.02	4.97

TABLE 3

Average production of scrubs, grades and purebreds

MONTH	SCRUBS			FIRST GRADES			SECOND GRADES			ALL PUREBREDS		
	Milk yield	Fat yield	Fat content	Milk yield	Fat yield	Fat content	Milk yield	Fat yield	Fat content	Milk yield	Fat yield	Fat content
	pounds	pounds	per cent	pounds	pounds	per cent	pounds	pounds	per cent	pounds	pounds	per cent
1	610.5	28.73	4.71	901.5	40.15	4.45	809.9	35.88	4.43	963.6	40.65	4.32
2	572.0	26.63	4.64	827.6	36.72	4.44	817.3	34.71	4.25	973.2	38.96	4.00
3	487.7	22.81	4.68	744.3	33.43	4.49	762.1	32.29	4.24	897.0	35.81	3.99
4	429.8	19.90	4.63	653.9	29.87	4.57	691.0	29.98	4.34	812.5	33.08	4.07
5	360.6	16.72	4.63	576.4	26.59	4.61	653.7	28.63	4.38	735.0	30.37	4.13
6	295.7	13.87	4.69	519.0	24.34	4.69	619.4	27.80	4.49	674.4	28.23	4.19
7	246.5	11.66	4.73	465.8	21.97	4.72	570.0	25.97	4.56	623.0	26.29	4.22
8	207.9	10.15	4.88	419.0	20.06	4.79	548.3	25.26	4.60	571.4	24.35	4.26
9	159.7	8.02	5.02	366.7	17.97	4.90	501.5	24.08	4.80	510.1	21.99	4.31
10	103.8	5.39	5.02	285.6	14.30	5.01	455.9	21.43	4.70	436.8	19.03	4.36
11	56.9	3.05	5.36	202.7	10.61	5.23	388.1	18.58	4.79	364.9	16.14	4.42
12	28.0	1.52	5.43	121.9	6.68	5.48	327.3	15.54	4.75	297.7	13.37	4.54
Year..	3559.1	168.46	4.73	6084.4	282.69	4.65	7144.5	320.15	4.48	7859.6	328.27	4.18

last month of the lactation and the average fat percentage for the whole year are higher than the average fat percentage for the first month of the lactation.

In the case of the Ayrshires there is a drop in fat content to the third month and this is maintained through the fourth. From then on the fat content increases fairly constantly. The

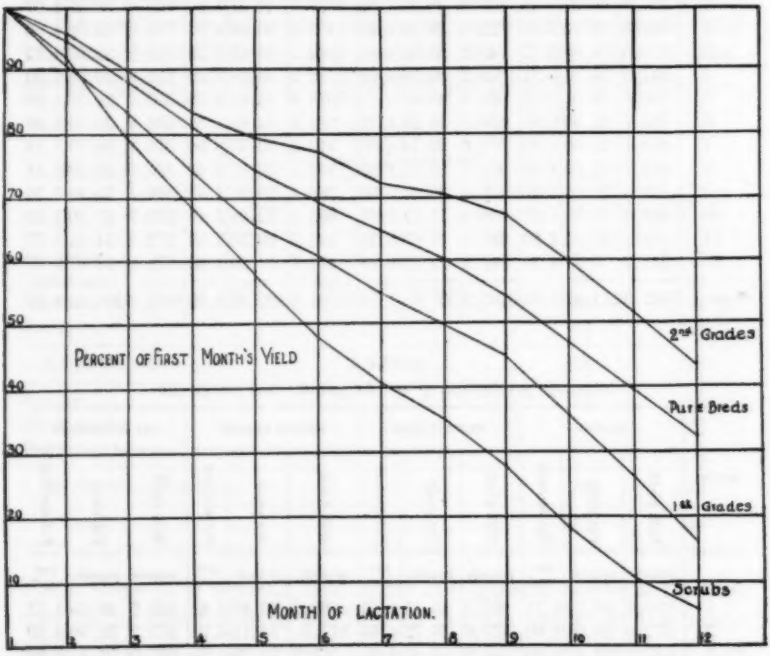

CHART 1. RELATIVE PERSISTENCY IN FAT PRODUCTION OF SCRUB, GRADE AND PUREBRED COWS

Holsteins show a drop in fat content to the third month with a rise from then to the end of the lactation period with but one insignificant change. In the case of both the Ayrshires and Holsteins the fat content of the first month's milk is apparently high and this level is not again reached until the twelfth month. Consequently, the average fat percentage for the year for each breed is lower than that for the first month of the lactation.

TABLE 4

Monthly production expressed as a percentage of the first month's production for the purebreds by breeds

MONTH	AYRSHIRE			GUERNSEY			HOLSTEIN			JERSEY		
	Milk yield	Fat yield	Fat content	Milk yield	Fat yield	Fat content	Milk yield	Fat yield	Fat content	Milk yield	Fat yield	Fat content
	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
1	100	100	100	100	100	100	100	100	100	100	100	100
2	104	93	89	99	96	97	104	94	91	98	99	100
3	97	86	88	90	88	98	96	85	89	90	92	102
4	87	77	88	80	81	100	88	79	90	81	85	105
5	79	71	90	72	74	103	79	71	90	75	80	107
6	74	68	91	67	70	103	73	66	91	67	73	109
7	69	63	91	61	65	104	67	62	92	62	68	110
8	63	58	92	55	60	107	63	59	93	56	62	110
9	57	53	92	49	54	109	57	53	94	49	55	112
10	46	44	96	42	46	114	49	46	95	43	49	114
11	33	32	99	34	39	113	43	42	97	35	41	115
12	23	23	100	30	33	114	35	35	99	29	34	115
Year...	834	768	92	781	805	103	854	792	93	781	837	106

TABLE 5

Monthly production expressed as a percentage of the first production for scrubs, grades and purebreds

MONTH	SCRUBS			FIRST GRADES			SECOND GRADES			ALL PUREBREDS		
	Milk yield	Fat yield	Fat content	Milk yield	Fat yield	Fat content	Milk yield	Fat yield	Fat content	Milk yield	Fat yield	Fat content
	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
1	100	100	100	100	100	100	100	100	100	100	100	100
2	94	93	99	92	92	100	101	97	96	101	96	95
3	80	79	99	83	83	101	94	90	96	93	88	95
4	70	69	98	73	74	103	85	84	98	84	81	97
5	59	58	98	64	66	104	81	80	99	76	75	98
6	49	48	100	58	61	105	77	78	101	70	69	99
7	40	41	100	52	55	106	70	72	103	65	65	100
8	34	35	104	47	50	108	68	70	104	59	60	101
9	26	28	107	41	45	110	62	67	108	53	54	102
10	17	19	107	32	36	113	56	60	106	45	47	103
11	9	11	114	23	26	118	48	52	108	38	40	105
12	5	5	115	14	17	123	40	43	107	31	33	106
Year...	583	586	100	675	704	105	882	892	101	876	808	99

From the summaries of the records prepared the production in the first month has been taken as 100 and the production in each succeeding month expressed as a percentage of the production of the first month. This gives a record of the persistency of production of the various breeds and grades. From this it is evident that those producing well in the first month do not always give the highest production for the year as their decrease in production may be rapid.

It will be found from chart 1 where fat production alone is considered that the scrubs declined most rapidly in production and their first month's production is also the lowest so they were the poorest producers. The first grades had a higher production during the first month than did the second grades but their decline in production was comparatively rapid and so they did not have as high an annual production as did the second generation of grades. On the other hand the second generation of grades did not have as high initial production as the purebreds and even though they did show remarkable persistency in production yet the average record of these individuals was not as great as the average for the pure purebreds.

SUMMARY

From the data presented here it would appear that:

1. High production at the beginning of the lactation period is not the only factor of importance in determining the production of a cow.
2. Persistency of production, coupled with high initial production, will lead to good production.
3. There is a general downward trend in milk and butterfat production from the beginning to the end of the lactation and with this would appear to go for the first month or two a decrease and later an increase in the fat content of the milk. This may be generally attributed to the fact that changes in the yield of fat, follow, but lag behind, the changes in the yield of milk.
4. Holsteins and Ayrshires showed the highest milk production in the second month and all others in the first month of the lactation.

5. In the case of the Jerseys the percentage of fat in the milk rises from the beginning to the end of the lactation period, while the Guernseys show a drop in the second month only. In both breeds the average fat percentage for the year is greater than the average for the first month.

6. The Ayrshires and Holsteins produce milk of decreasing fat content for some time after freshening and the average fat content of the milk for the year is less than for the first month.

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RELATION OF MILK PRODUCTION TO THE TWINNING TENDENCY[1]

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Upon first thought it seems unreasonable to think of any relation between high milk production and multiple births in cattle. However, when we reflect that twinning in cattle is but one of the evidences of high fertility and that high fertility has been found to be closely correlated with high milk production (1), such a relationship does not seem so unreasonable. The writer, in order to determine whether or not such a relationship does exist has made a study of a random sample of 357 dams of multiple offspring in the Holstein-Friesian breed.

In this study are included the dams of all the male twins in volume 35 of the herd-book, and the dams of all the female twins indicated in volume 40, up to number 474,273. There were a total, then, of 165 dams of male twins or male and freemartin, and a total of 192 dams of female twins. The two groups were kept separate as the males are selected more rigorously than the females, and thus the dams of registered males are more likely to have records than the dams of registered females. The A. R. O. records of the dams of the twins were compiled, the problem being, "Do the dams of twins produce more milk than the dams of singles." Of course, if one group did produce more than the other, it would be indicated, not by a higher average A. R. O. production, but by a larger number of animals making the A. R. O. requirements. The table given below shows the results of the study:

[1] A part of a thesis, Twinning in Dairy Cattle, submitted in partial fulfillment of the requirements for graduation.

	per cent
Percentage of dams (of twins indicated in the list of males) having records	55.7
Percentage of dams (of twins indicated in the list of females) having records	45.8
Percentage of all registered females having records[2]	20.4

According to the above table, then, the dam of twins has more than twice as good a chance to make the A. R. O. requirements as the ordinary female. However, right here an error enters in. We are comparing a selected group of females (mature cows that have produced living offspring) with the whole group of females. The question which enters in is, how many females, once registered, fail to produce living offspring? The writer could get no definite data with which to correct the error, but did get the opinions of several well informed men upon the question. Their estimates varied from 2 to 12 per cent. Using the highest figure which the reader will admit seems rather high, the percentages remain 32.4 per cent of all dams making the A. R. O. and 55.7 and 45.8 per cent respectively for the dams of twins.

It is interesting to note in the consideration of this question that 82.7 per cent of the sires of the dams of twins in this list had at least one daughter in the advanced registry. The average number of daughters for those sires of twin producers having daughters in the advanced registry was over sixteen. The reader may use his own judgment as to whether or not this seems higher than in the average pedigree.

Another important fact is that great animals such as century sires recur very often in the pedigrees of twins. This is true of all pedigrees because of constant selection, but is it true to the same extent? For example, Hengerveld DeKol 23102 occurs as the grandsire of 5 per cent of the twin producers whose twins are registered in volume 35 of the herd-book. If he occurred in the same proportion for all animals he must needs have 750

[2] The writer judged that all females registered before August 17, 1918, had had an opportunity to make the A. R. O. requirements before the 1922 Advanced Registry Yearbook was published. While some will make records that have not already done so, it was thought that an equal number registered since that date have made records.

·*Sarcastic Lad 23971*
·Johanna Aaggies Sarcastic Lad
26935
·Aaggie Cornucopia Johanna Lad 32554 ·Johanna Aaggie
·Aaggie Cornucopia Pauline
48426
Aaggie Cornucopia Johanna Lad 11th
87681
·Edith Grace Piebe
82626

·*Sarcastic Lad 23971*
Johanna Sarcastic Cornucopia (Twin)
261769
Also the dam of Twins
·Johanna Aaggie's Sarcastic Lad
26935
·Johanna Aaggie
·Lileth Paul DeKol's Son
30412
Sir Grace DeKol Joh. Paul 35408 ·Lileth Pauline DeKol
Otego Valley Sarcastic 125547 ·Grace DeKol 2d 54789
Sarcastic Lad 23971
Johanna Aaggie's Sarcastic Lad
26935
Johanna Aaggie
Madlinette Sarcastic
80265
Catrina 5th's Pieterje
39113

Hengerveld DeKol
23102

Sarcastic Lad
23971

Hengerveld DeKol 5th (Twin)
54721

Joh. Rue 3d's Lad
26934

Belle Neth. Joh
62304

Johanna Rue 3d

Marcella Hengerveld DeKol
70519

Belle Neth. Clothilde
33836

Marcella Lote 66034

Grace Darling Hengerveld.
242862
The dam of five sets of Twins

Sarcastic Lad
23971

Tina Clay DeKol Lad
42450

Tina Clay DeKol
57350

Grace Darling of Wooster
242861
Dam of nine singles only

Sarcastic Lad
23971

Tina Clay DeKol Lad
42450

Grace Daw 2d
242860
Dam of ten singles and Twins

Tina Clay DeKol
57350

Grace Daw 64996

granddaughters having *sons* registered in the single herdbook volume 35 which contains registrations for six and one-half months. Such a performance is, of course, rather doubtful. Similar examples of Pontiac Korndyke, King of the Pontiacs, King Segis, King Korndyke Manor DeKol and others might be pointed out. Sarcastic Lad 23971 seems to be a carrier of the twinning tendency. Two pedigrees of very fertile families are given herewith showing the relation of the name of Sarcastic Lad to twinning. Pedigrees of a similar nature showing the occurrence of the other great bulls named above in relation to twinning might also be given.

Objection has been made to the theme of this article upon the grounds that world's records have not been made by twins. In answer it is interesting to point out that the world's record milk production for a junior-two-year-old was recently broken by a freemartin, Woodbine Rosa Prilly, in California. She carried calf five months and gained several hundred pounds in weight during the test. Also the record of Pontiac Clothilde DeKol 2d, a dam of twins, who produced 1017.28 pounds of fat as early as 1910. Grace Darling Hengerveld, who calved five sets of twins, also produced (unofficial) 21,528 pounds of milk and 1023 pounds of fat in a single milking period of 658 days.

It is to be admitted that the above discussion does not include enough numbers nor sufficient data to furnish absolute proof. It is submitted in the hope that interest in the problem may be stimulated and that in the end the dairy industry may benefit. Conclusions that may be drawn from the limited data at hand are:

1. According to authority, there is a definite relationship between high fertility and high milk production, and partial sterility and low milk production.

2. This relationship seems to hold true when high fertility is evidenced in the production of twins.

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THE EFFECT OF AN INCOMPLETE REMOVAL OF MILK FROM THE UDDER ON THE QUANTITY AND COMPOSITION OF THE MILK PRODUCED DURING THE IMMEDIATE SUBSEQUENT MILKINGS

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The necessity of a preliminary milking as required by some of the pure bred dairy cattle clubs in advanced registry testing has caused a great deal of discussion of late among the dairy cattle clubs and the agricultural colleges and experiment stations supervising advanced registry testing. If no preliminary milking is taken, i.e., if the supervisor in charge of the test does not see that the cow is milked dry at the milking previous to the starting of the test, it is possible for the milker to leave a portion of the milk in the cow's udder and by so doing change the quantity and composition of the milk produced at the succeeding milkings. Such a change in the composition of the milk produced has been demonstrated by Regan and Mead (1) and Fitch, Becker and McGilliard (2) and the proof of this change based upon an observed increase in the percentage fat content and quantity of milk produced. The percentage fat content of milk, however, is extremely variable from one milking to another, and may be influenced to a great extent by factors other than the leaving of a portion of the milk within the udder.[1] On the other hand, Jackson and Rothera (3) have shown that certain constituents of milk (percentage lactose and ash contents) which under normal conditions are approximately constant from one milking to another, when once disturbed show a marked variation and return to their original condition very slowly. This variation in the percentage lactose and ash contents was produced by returning a portion of the milk to

[1] The influence of such factors upon the percentage fat content of milk has been demonstrated by Anderson (4) Rasmussen (5) and Armsby (6).

the udder after it was milked dry. During the immediate subsequent milkings the percentage lactose content was markedly decreased and the percentage ash content similarly increased.

In an investigation by the author wherein a portion of the milk was returned to the udder after a dry milking, it was found that

TABLE A

Effect of returning milk to the udder

Cow 276, pure bred Jersey; age three years seven months; calved August 24, 1922; milked two times per day, September 25, p.m. to October 4, p.m., 1922.

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	1.7	4.0	0.068	5.33	0.091	4.48	0.076	13.81	0.235
	2.5	4.45	0.111	5.20	0.130	4.03	0.101	13.68	0.342
	2.4	6.2	0.149	5.50	0.132	3.78	0.091	15.48	0.372
	2.3	4.6	0.106	5.29	0.122	3.76	0.086	13.65	0.314
	2.1	4.9	0.103	5.25	0.110	3.94	0.083	14.09	0.296
	2.3	4.1	0.094	5.30	0.122	3.84	0.088	13.24	0.305
	2.0	4.1	0.082	5.33	0.107	4.17	0.083	13.60	0.272
	2.3	5.0	0.115	5.29	0.122	3.83	0.088	14.12	0.325
	1.9	4.35	0.083	5.24	0.100	3.91	0.074	13.50	0.257
	2.2	5.1	0.112	5.18	0.114	4.11	0.090	14.39	0.317
Milk returned	1.5	2.65	0.040	5.27	0.079	4.07	0.061	11.99	0.180
Subsequent milkings	2.8	5.20	0.146	2.54	0.071	4.94	0.138	12.68	0.355
	0.4	9.10	0.036	3.71	0.015	6.35	0.025	19.16	0.077
	1.4	5.25	0.074	3.66	0.051	6.14	0.086	15.05	0.211
	1.1	4.20	0.046	4.45	0.049	4.86	0.053	13.51	0.149
Average preliminary milkings	2.17	4.71	0.102	5.30	0.115	3.96	0.086	13.99	0.304
Average subsequent milkings	1.43	5.30	0.076	3.26	0.047	5.30	0.076	13.90	0.198

during the immediate subsequent milkings the percentage lactose content was markedly decreased and the percentage protein + ash content similarly increased. Table A and figure A give the results from one of a series of trials all of which gave corresponding results.

The figures in this table represent the production for one-quarter of the udder. Approximately 0.66 pound of milk was returned

to the quarter. Bacterial analysis showed that the milk returned to the quarter was practically free from bacteria.

From figure A it is quite evident that during the subsequent milking the percentage lactose and protein + ash contents markedly deviate from their normal condition and then return to it very slowly. The percentage fat content shows a marked

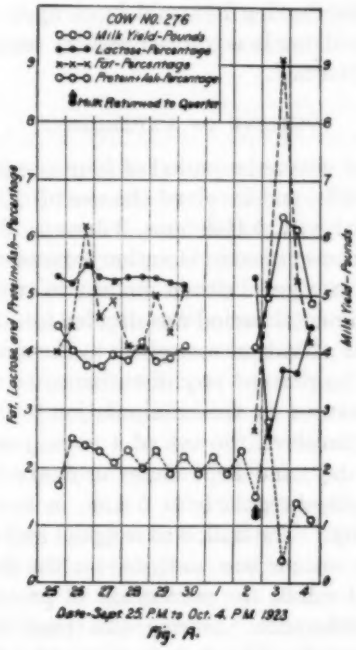


Fig. A.

increase, the greatest increase generally falling on the second milking after the return of milk to the udder. It might be well to point out at this time that such a manipulation could be carried on in advanced registry testing and the percentage fat content greatly increased by returning only a small amount of milk to the udder *shortly* after it was milked dry.

Although the returning of a certain portion of milk to the udder is not the same as leaving a similar portion within the udder by

means of an incomplete milking, it was supposed that the effects produced would be somewhat of the same nature. Futhermore, in case this latter relation held true for all cows, it would be possible by means of a sugar determination of the milk produced at each milking during a two-day test, to detect with relative certainty an incomplete milking any time during the test or within the first two or three milkings previous to the starting of the test. In view of this fact and the bearing it would have upon the requirement of a preliminary milking in advanced registry testing the following experiment was planned.

OUTLINE OF EXPERIMENT

The experiment covered a period of four months—from March 26 to July 27, 1923—and involved the use of 12 pure bred cows in the college herd; viz., 5 Holsteins, 3 Jerseys, 3 Guernseys, and 1 Ayrshire. The cows varied in lactation from one to nine months and ranged from two years eleven months to twelve years of age. The entire experimental period was divided into 10 sub-periods or trials. Particular attention was given to the environment of the animals in order to prevent any disturbance to their production other than that caused by the manipulation.[2]

The first trial involved the use of 4 cows, one of each breed, milked twice a day, and kept under ordinary herd conditions. The cows were milked regularly at 5 a.m. in the morning and 5 p.m. in the evening. The milk was weighed and sampled at each milking and each sample was analyzed for the percentage of fat, lactose, and total solids, the percentage of protein + ash being determined by difference. During this trial 19 milkings were weighed and sampled. The first 8 of the 19 milkings were considered as a preliminary period. At the 15th milking one-fourth of the average milk yield, as computed from the 7 previous corresponding milkings, was left in the udder. The 4 milkings succeeding the manipulation were regarded as comparable to a semi-official two-day test and their average compared to the average of the 8 preliminary milkings.

[2] The leaving of the milk within the udder by means of an incomplete milking will hereinafter be designated as manipulation.

The procedure in the second trial was identical to that in the first trial with the exception that it included only 17 milkings, the first 8 of which were considered as a preliminary period. At the 13th milking one-half of the average milk yield as computed from the 6 previous corresponding milkings, was left in the udder. The Jersey cow 289 used in the first trial was replaced by a Holstein cow 288 because of the Jersey being too far advanced in her lactation. The Guernsey cow 278 went off feed and her record had to be discarded, making a total of only 3 complete records in this trial.

After completing the first two trials with cows milked twice a day, it was decided to continue the experiment with cows on official test, milking 4 times a day. A series of 8 trials then followed, each trial involving the use of one cow and covering a period of four days. Seven cows were used during these trials, 3 Holsteins, 2 Jerseys, and 2 Guernseys, one Guernsey being run twice. Each trial included 17 milkings, all of which were individually weighed and sampled. Each sample, within twenty-four hours after it was taken, was analyzed for the percentage of fat, lactose and total solids, the percentage of protein + ash being determined by difference. The first 8 of the 17 milkings were regarded as a two-day preliminary period. At the 9th milking one-half of the average milk yield, as computed from the 4 previous p.m. milkings, was left in the udder. The 8 milkings subsequent to the manipulation were regarded as comparable to a semi-official two-day test and compared with the 8 preliminary milkings.

In the first two trials the percentage of fat was determined by the Babcock method, the percentage of lactose by the polariscope method, and the percentage of total solids by the gravimetric method. The results obtained from the first two trials indicated that the Babcock method, for determining the percentage of butterfat in milk, was very susceptible to experimental errors which made it rather difficult to accurately determine small differences in percentage. In view of this fact and the necessity for the most accurate results, the Babcock method in trials III to X was replaced by the Roese-Gottlieb method, the percentages of lactose, total solids and protein + ash being determined the same as in

trials I and II. During the preliminary milkings of each trial the front quarters of the udder were milked as one unit and likewise the rear quarters, and the milk weights recorded separately for the respective pairs. Such a procedure was necessary in order to insure an even distribution of milk between the quarters of the udder when the udder was not milked dry.

EXPERIMENTAL RESULTS

The results from the various trials are reported in tables 1 to 15 and figures 1 to 15. Each table and figure represents the production of one cow. Although the results in tables 1 to 15 are in very few cases as striking as those in table A, there is a general tendency towards the latter. The average increases and decreases in the percentage fat, lactose and protein + ash contents and the yields of fat and milk, as determined from the preliminary and subsequent milkings, were in most cases not very great, and it was necessary to set a standard below which differences were not considered as significant.[3] In very few cases do the graphs in figures 1 to 15 show as marked a disturbance in the various percentage contents and yields as do the graphs in figure A.

Tables 1 to 4 and figures 1 to 4 include the results of the first trial. The cows were milked twice a day during this trial and one-fourth of the average milk yield was left in the udder. Of the 4 cows tested, one showed a significant average increase in the yield of milk and 2 a significant average increase in both the percentage fat content and the yield of fat. Three of the four cows showed a significant average decrease in the percentage lactose content and two a significant average increase in the percentage protein + ash content. The Jersey cow 289 was the only cow to show significant differences in the percentage fat, lactose and protein + ash contents similar to those found in table A. The Ayrshire cow 277 was the only cow to show no significant differences in any of the above mentioned percentage contents and yields.

[3] A significant average increase or decrease was considered as not less than 0.1 for percentage content, 0.71 pound for milk yield, and 0.03 pound for fat yield.

TABLE 1

Effect of an incomplete milking

Cow 200, pure bred Holstein; age 10 years 2 months; calved August 27, 1922; milked 2 times per day; March 26, p.m. to April 6, p.m. 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	15.8	3.20	0.506	4.69	0.741	3.52	0.556	11.41	1.803
	18.5	3.60	0.666	4.77	0.882	3.65	0.675	12.02	2.224
	17.3	3.35	0.580	4.78	0.827	3.29	0.569	11.42	1.976
	18.5	3.60	0.666	4.77	0.882	3.44	0.636	11.81	2.185
	18.2	3.40	0.619	4.57	0.832	3.69	0.672	11.66	2.122
	17.2	3.60	0.619	4.73	0.814	3.64	0.626	11.97	2.059
	18.0	3.45	0.621	4.55	0.819	3.61	0.650	11.61	2.090
	17.6	3.75	0.660	4.69	0.825	3.45	0.607	11.89	2.093
Incomplete milking	13.0	2.60	0.338	4.36	0.567	3.62	0.471	10.58	1.375
Subsequent milkings	18.9	3.70	0.699	4.10	0.775	3.97	0.750	11.77	2.225
	15.3	3.65	0.558	4.50	0.689	3.56	0.545	11.71	1.792
	17.6	3.45	0.607	4.58	0.806	3.48	0.612	11.51	2.026
	16.9	3.50	0.592	4.54	0.767	3.52	0.595	11.56	1.954
Average preliminary milkings	17.64	3.50	0.617	4.69	0.823	3.54	0.624	11.73	2.069
Average subsequent milkings	17.18	3.58	0.614	4.42	0.759	3.64	0.625	11.64	1.999

TABLE 2

Effect of an incomplete milking

Cow 289, pure bred Jersey; age seven years two months; calved May 21, 1922; milked two times per day; March 26, p.m. to April 6, p.m. 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	7.5	6.45	0.484	5.30	0.398	4.70	0.353	16.45	1.234
	5.5	5.15	0.283	5.57	0.306	4.70	0.259	15.42	0.848
	7.4	6.55	0.485	5.33	0.394	4.51	0.334	16.39	1.213
	6.0	5.55	0.333	5.57	0.334	4.56	0.274	15.68	0.941
	7.3	6.05	0.442	5.31	0.388	4.51	0.329	15.87	1.159
	6.7	6.60	0.442	5.33	0.357	4.63	0.310	16.56	1.110
	6.6	5.55	0.366	5.26	0.347	4.83	0.319	15.64	1.032
	7.1	6.30	0.447	5.49	0.390	4.62	0.328	16.41	1.165
Incomplete milking	5.2	4.35	0.226	5.29	0.275	4.75	0.247	14.39	0.748
Subsequent milkings	9.6	6.70	0.643	5.29	0.508	4.61	0.443	16.60	1.594
	6.7	6.20	0.415	5.15	0.345	4.71	0.316	16.06	1.076
	7.4	6.95	0.514	5.23	0.387	4.78	0.354	16.96	1.255
	7.0	6.15	0.431	5.08	0.356	4.85	0.340	16.08	1.126
Average preliminary milkings	6.76	6.07	0.410	5.39	0.364	4.63	0.313	16.09	1.088
Average subsequent milkings	7.70	6.52	0.501	5.20	0.399	4.73	0.363	16.45	1.263

TABLE 3

Effect of an incomplete milking

Cow 278, pure bred Guernsey; age four years one month; calved May 5, 1922; milked two times per day; March 26, p.m. to April 6, p.m., 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	15.0	5.95	0.893	5.38	0.807	4.14	0.621	15.47	2.321
	15.1	4.60	0.695	5.36	0.809	4.11	0.621	14.07	2.125
	17.6	5.50	0.968	5.19	0.913	4.08	0.718	14.77	2.600
	15.8	4.75	0.751	5.34	0.844	4.01	0.634	14.10	2.228
	16.7	5.25	0.877	5.35	0.893	3.97	0.663	14.57	2.433
	15.0	5.15	0.773	5.46	0.819	4.19	0.629	14.80	2.220
	16.7	5.2	0.868	5.28	0.882	3.85	0.643	14.33	2.393
	15.3	5.0	0.765	5.56	0.851	3.91	0.598	14.47	2.214
Incomplete milking	11.7	3.7	0.433	5.37	0.628	4.07	0.476	13.14	1.537
Subsequent milkings	20.0	5.35	1.070	5.13	1.026	3.95	0.790	14.43	2.886
	14.9	5.65	0.842	5.14	0.766	4.04	0.602	14.83	2.210
	15.1	5.10	0.770	5.08	0.767	4.09	0.618	14.27	2.155
	14.8	5.10	0.755	5.11	0.756	4.13	0.611	14.34	2.122
Average preliminary milkings	15.9	5.18	0.824	5.36	0.852	4.03	0.641	14.57	2.317
Average subsequent milkings	16.2	5.30	0.859	5.12	0.829	4.03	0.653	14.46	2.343

TABLE 4

Effect of an incomplete milking

Cow 277, pure bred Ayrshire; age four years two months; calved March 2, 1923; milked two times per day; March 26, p.m. to April 6, p.m. 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	15.8	5.65	0.893	5.30	0.837	3.70	0.585	14.65	2.315
	15.2	5.10	0.775	5.49	0.834	3.87	0.588	14.46	2.198
	16.5	4.95	0.817	5.31	0.876	3.55	0.586	13.81	2.279
	15.8	5.40	0.853	5.42	0.856	3.67	0.580	14.49	2.289
	15.6	4.60	0.718	5.28	0.824	3.52	0.549	13.40	2.090
	16.2	5.10	0.826	5.38	0.872	3.65	0.591	14.13	2.289
	16.2	4.50	0.729	5.30	0.859	3.57	0.578	13.37	2.166
	16.6	5.25	0.872	5.37	0.891	3.52	0.584	14.14	2.347
Incomplete milking	11.9	2.95	0.351	5.38	0.640	3.80	0.452	12.13	1.443
Subsequent milkings	19.8	5.75	1.139	5.43	1.075	3.56	0.705	14.74	2.919
	13.9	4.15	0.577	5.42	0.753	3.74	0.520	13.31	1.850
	14.7	5.35	0.786	5.59	0.822	3.70	0.544	14.64	2.152
	15.8	5.10	0.806	5.22	0.825	3.62	0.572	13.94	2.203
Average preliminary milkings	15.99	5.07	0.810	5.36	0.856	3.63	0.580	14.05	2.246
Average subsequent milkings	16.05	5.15	0.827	5.41	0.869	3.65	0.585	14.21	2.281

TABLE 5

Effect of an incomplete milking

Cow 200, pure bred Holstein; age ten years three months; calved August 27, 1922; milked two times per day; April 24, p.m. to May 4, p.m., 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	15.2	2.90	0.441	4.65	0.707	3.70	0.562	11.25	1.710
	16.7	3.60	0.601	4.58	0.765	3.71	0.620	11.89	1.986
	14.4	3.45	0.497	4.48	0.645	3.78	0.544	11.71	1.686
	15.4	3.50	0.539	4.50	0.693	3.63	0.559	11.63	1.791
	13.2	3.30	0.436	4.58	0.605	3.46	0.457	11.34	1.497
	14.9	3.45	0.514	4.56	0.679	3.72	0.554	11.73	1.748
	13.8	3.70	0.511	4.56	0.629	3.69	0.509	11.95	1.649
	14.6	3.20	0.467	4.57	0.667	3.74	0.546	11.51	1.680
Incomplete milking	7.3	2.80	0.204	4.51	0.329	3.54	0.258	10.85	0.792
Subsequent milkings	18.3	3.40	0.622	4.29	0.785	3.58	0.665	11.27	2.062
	13.7	4.00	0.548	4.21	0.577	3.61	0.495	11.82	1.619
	15.6	3.30	0.515	4.33	0.675	3.84	0.599	11.47	1.789
	15.8	3.60	0.569	4.48	0.708	3.57	0.564	11.65	1.841
Average preliminary milkings	14.78	3.39	0.501	4.56	0.674	3.68	0.544	11.63	1.718
Average subsequent milkings	15.85	3.56	0.563	4.33	0.686	3.65	0.578	11.53	1.828

TABLE 6

Effect of an incomplete milking

Cow 288, pure bred Holstein; age four years; calved June 27, 1922; milked two times per day; April 24, p.m. to May 4, p.m., 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	10.3	3.25	0.335	5.12	0.527	4.23	0.436	12.60	1.298
	10.9	3.10	0.338	4.95	0.540	4.15	0.452	12.20	1.330
	9.6	3.45	0.331	5.18	0.497	4.13	0.396	12.76	1.225
	10.5	3.25	0.341	5.01	0.526	4.13	0.434	12.39	1.301
	9.5	3.50	0.333	5.13	0.487	4.31	0.409	12.94	1.229
	9.5	3.70	0.352	5.35	0.508	4.16	0.395	13.21	1.255
	8.1	3.40	0.275	5.05	0.409	4.16	0.337	12.61	1.021
	10.6	3.50	0.371	5.05	0.535	4.20	0.445	12.75	1.352
Incomplete milking	5.2	3.20	0.166	5.15	0.268	4.02	0.209	12.37	0.643
Subsequent milkings	12.9	3.70	0.477	4.98	0.642	4.17	0.538	12.85	1.658
	8.8	4.20	0.370	4.94	0.435	4.16	0.366	13.30	1.170
	10.1	3.45	0.348	5.00	0.505	4.22	0.426	12.67	1.280
	9.5	3.50	0.333	5.14	0.488	4.07	0.387	12.71	1.207
Average preliminary milkings	9.88	3.39	0.334	5.10	0.504	4.18	0.413	12.67	1.251
Average subsequent milkings	10.33	3.70	0.382	5.00	0.517	4.16	0.429	12.87	1.329

TABLE 7

Effect of an incomplete milking

Cow 277, pure bred Ayrshire; age four years three months; calved March 2, 1923; milked two times per day; April 24, p.m. to May 4, p.m., 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	14.8	3.85	0.570	5.22	0.773	3.97	0.588	13.04	1.930
	14.2	3.70	0.525	5.33	0.757	4.19	0.595	13.22	1.877
	16.0	4.30	0.688	5.02	0.803	3.92	0.627	13.24	2.118
	16.4	4.50	0.738	5.16	0.846	3.86	0.633	13.52	2.217
	13.3	4.70	0.625	5.11	0.680	3.93	0.523	13.74	1.827
	14.3	3.90	0.558	5.12	0.732	3.95	0.565	12.97	1.855
	14.3	4.30	0.615	5.07	0.725	3.87	0.553	13.24	1.893
	14.6	4.70	0.686	5.25	0.767	3.93	0.574	13.88	2.026
Incomplete milking	7.1	2.50	0.178	5.22	0.371	3.89	0.276	11.61	0.824
Subsequent milkings	17.2	5.20	0.894	5.06	0.870	3.67	0.631	13.93	2.396
	13.2	4.85	0.640	5.07	0.669	3.93	0.519	13.85	1.828
	12.8	4.70	0.602	5.34	0.684	3.82	0.489	13.86	1.774
	12.8	5.40	0.691	5.21	0.667	3.66	0.468	14.27	1.827
Average preliminary milkings	14.74	4.25	0.626	5.16	0.760	3.95	0.582	13.35	1.968
Average subsequent milkings	14.00	5.05	0.707	5.16	0.722	3.76	0.527	13.97	1.956

TABLE 8

Effect of an incomplete milking

Cow 254, pure bred Holstein; Age eight years five months; calved October 27, 1922; milked four times per day; May 21, p.m. to May 25, p.m., 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	14.0	2.81	0.393	4.57	0.640	3.70	0.518	11.08	1.551
	13.2	3.10	0.409	4.84	0.639	3.61	0.477	11.55	1.525
	14.2	3.34	0.474	4.96	0.704	3.66	0.520	11.95	1.697
	13.1	3.22	0.422	4.87	0.638	3.50	0.459	11.59	1.518
	14.5	3.03	0.439	4.81	0.697	3.41	0.494	11.24	1.630
	13.5	3.13	0.423	4.78	0.645	3.54	0.478	11.45	1.546
	15.7	3.09	0.485	4.75	0.746	3.57	0.560	11.41	1.791
	13.9	3.27	0.455	4.69	0.652	3.63	0.505	11.59	1.611
Incomplete milking	6.7	2.07	0.139	4.57	0.306	3.66	0.245	10.30	0.690
Subsequent milkings	22.4	2.93	0.656	4.60	1.030	3.66	0.820	11.19	2.507
	15.7	3.12	0.490	4.58	0.719	3.83	0.601	11.53	1.810
	14.4	3.26	0.469	4.65	0.670	3.86	0.556	11.77	1.695
	14.2	2.71	0.385	4.58	0.650	3.53	0.501	10.82	1.536
	15.2	3.00	0.456	4.57	0.695	3.78	0.575	11.35	1.725
	15.8	2.82	0.446	4.57	0.722	3.76	0.594	11.15	1.762
	14.3	3.09	0.442	4.56	0.652	3.84	0.549	11.49	1.643
	14.7	2.79	0.410	4.56	0.670	3.70	0.544	11.05	1.624
Average preliminary milkings	14.01	3.12	0.437	4.78	0.670	3.58	0.501	11.48	1.608
Average subsequent milkings	15.84	2.96	0.469	4.58	0.726	3.74	0.592	11.29	1.788

TABLE 9

Effect of an incomplete milking

Cow 306, pure bred, Jersey; Age six years nine months; calved January 26, 1923
milked four times per day; June 4, p.m. to June 8, p.m., 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	6.8	4.71	0.320	5.05	0.343	4.58	0.311	14.34	0.975
	6.3	5.50	0.347	5.04	0.318	4.56	0.287	15.10	0.951
	7.1	5.71	0.405	5.07	0.360	4.54	0.322	15.32	1.088
	8.1	4.94	0.400	5.06	0.410	4.74	0.384	14.74	1.194
	6.5	5.29	0.344	5.07	0.330	4.52	0.294	14.88	0.967
	7.5	5.80	0.435	5.05	0.379	4.55	0.341	15.40	1.155
	6.3	4.83	0.304	5.07	0.319	4.63	0.292	14.53	0.916
	6.8	5.25	0.357	5.06	0.344	4.66	0.317	14.97	1.018
Incomplete milking	3.6	3.50	0.126	5.33	0.192	4.77	0.172	13.60	0.490
Subsequent milkings	9.2	5.26	0.484	4.96	0.456	4.51	0.415	14.73	1.355
	5.8	5.43	0.315	5.12	0.297	4.64	0.269	15.19	0.881
	7.2	5.24	0.377	5.20	0.374	4.64	0.334	15.08	1.086
	5.3	5.36	0.284	5.25	0.278	4.62	0.245	15.23	0.807
	8.0	5.01	0.401	5.09	0.407	4.36	0.349	14.46	1.157
	7.2	5.63	0.405	5.06	0.364	4.37	0.315	15.06	1.084
	6.6	5.77	0.381	5.06	0.334	4.53	0.299	15.36	1.014
	7.0	5.55	0.389	5.22	0.365	4.35	0.305	15.12	1.058
Average preliminary milkings	6.93	5.26	0.364	5.06	0.350	4.60	0.318	14.92	1.033
Average subsequent milkings	7.04	5.39	0.379	5.11	0.359	4.50	0.316	15.00	1.055

TABLE 10

Effect of an incomplete milking

Cow 297, pure bred Guernsey; age six years seven months; calved November 20, 1922; milked four times per day; June 11, p.m. to June 15, p.m., 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		lbs.		lbs.		lbs.		lbs.
Preliminary milkings	8.7	4.26	0.371	5.34	0.465	4.12	0.358	13.72	1.194
	9.1	4.86	0.442	5.37	0.489	4.40	0.400	14.63	1.331
	10.6	5.04	0.534	5.34	0.566	4.25	0.451	14.63	1.551
	9.6	5.23	0.502	5.24	0.503	4.28	0.411	14.75	1.416
	10.1	4.83	0.488	5.33	0.538	4.08	0.412	14.24	1.438
	8.8	4.98	0.438	5.33	0.469	4.32	0.380	14.63	1.287
	11.0	5.27	0.580	5.37	0.591	4.31	0.474	14.95	1.645
	9.3	5.43	0.505	5.28	0.491	4.20	0.391	14.91	1.387
Incomplete milking	4.6	3.80	0.353	5.30	0.493	4.21	0.392	13.31	1.387
Subsequent milkings	13.3	4.43	0.589	5.37	0.714	4.34	0.577	14.14	1.881
	10.0	8.96	0.896	5.28	0.528	3.71	0.371	17.95	1.795
	8.2	5.31	0.434	5.34	0.438	4.38	0.359	15.03	1.232
	8.8	4.86	0.428	5.26	0.463	4.19	0.369	14.31	1.259
	8.7	5.07	0.441	5.31	0.462	4.49	0.391	14.87	1.294
	10.9	5.21	0.568	5.29	0.577	4.27	0.465	14.77	1.610
	8.9	5.47	0.487	5.30	0.472	4.17	0.371	14.94	1.330
	9.8	4.61	0.452	5.32	0.521	4.16	0.408	14.09	1.381
Average preliminary milkings	9.65	5.00	0.482	5.33	0.514	4.25	0.409	14.57	1.406
Average subsequent milkings	9.83	5.46	0.537	5.31	0.522	4.21	0.414	14.99	1.472

TABLE 11

Effect of an incomplete milking

Cow 263, pure bred Holstein; age five years six months; calved October 28, 1922; milked four times per day; June 18, p.m. to June 22 p.m., 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		lbs.		lbs.		lbs.		lbs.
Preliminary milkings	17.6	3.39	0.597	4.52	0.796	3.37	0.593	11.28	1.985
	14.8	3.35	0.496	4.71	0.697	3.58	0.530	11.64	1.723
	16.5	2.52	0.416	4.59	0.757	3.39	0.559	10.50	1.733
	16.8	3.09	0.519	4.56	0.766	3.35	0.563	11.00	1.848
	15.6	2.83	0.441	4.59	0.716	3.92	0.612	11.34	1.769
	14.5	3.32	0.481	4.75	0.689	3.50	0.508	11.57	1.678
	17.7	3.33	0.589	4.66	0.825	3.68	0.651	11.67	2.066
	15.4	3.22	0.496	4.54	0.699	3.66	0.564	11.42	1.759
Incomplete milking	7.9	2.19	0.173	4.61	0.364	3.44	0.272	10.24	0.809
Subsequent milkings	20.1	2.86	0.575	4.56	0.917	3.70	0.744	11.12	2.235
	18.0	2.94	0.529	4.47	0.805	3.49	0.628	10.90	1.962
	16.8	3.40	0.571	4.49	0.754	3.54	0.595	11.43	1.920
	15.1	2.60	0.393	4.50	0.680	3.56	0.538	10.66	1.610
	18.6	3.06	0.569	4.62	0.859	3.67	0.683	11.35	2.111
	18.2	2.99	0.544	4.46	0.812	3.49	0.635	10.94	1.991
	16.2	2.98	0.483	4.39	0.711	3.72	0.603	11.09	1.797
	17.7	3.22	0.570	4.49	0.795	3.60	0.637	11.31	2.002
Average preliminary milkings	16.11	3.13	0.504	4.61	0.743	3.55	0.572	11.30	1.820
Average subsequent milkings	17.59	3.01	0.529	4.50	0.791	3.60	0.633	11.11	1.953

TABLE 12

Effect of an incomplete milking

Cow 297, pure bred Guernsey; age six years seven months; calved November 20, 1922; milked four times per day; June 25, p.m. to June 29, p.m., 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	8.6	4.32	0.372	5.20	0.447	3.97	0.341	13.49	1.160
	7.7	4.21	0.324	5.17	0.398	4.32	0.333	13.70	1.055
	9.0	4.89	0.440	5.27	0.474	4.11	0.370	14.27	1.284
	7.9	4.33	0.342	5.24	0.414	4.22	0.333	13.79	1.089
	10.3	5.09	0.524	5.21	0.537	3.98	0.410	14.28	1.471
	7.0	4.72	0.330	5.40	0.378	4.29	0.300	14.41	1.009
	9.6	4.95	0.475	5.29	0.508	4.03	0.387	14.27	1.370
	8.4	5.49	0.461	5.27	0.443	4.24	0.356	15.00	1.260
Incomplete milking	3.5	3.70	0.130	5.30	0.186	3.90	0.137	12.90	0.452
Subsequent milkings	13.0	4.71	0.612	5.37	0.698	4.31	0.560	14.39	1.871
	9.1	6.02	0.548	5.48	0.497	4.40	0.400	15.90	1.447
	8.1	5.69	0.461	5.35	0.433	4.26	0.345	15.30	1.239
	8.6	4.45	0.383	5.24	0.451	4.25	0.366	13.94	1.199
	8.2	4.97	0.408	5.37	0.440	4.34	0.356	14.68	1.204
	9.6	5.33	0.512	5.36	0.515	4.16	0.399	14.85	1.426
	8.4	4.64	0.390	5.34	0.449	4.24	0.356	14.22	1.194
	9.8	5.07	0.497	5.20	0.510	4.00	0.392	14.27	1.398
Average preliminary milkings	8.56	4.77	0.408	5.25	0.450	4.13	0.353	14.16	1.212
Average subsequent milkings	9.35	5.10	0.476	5.34	0.499	4.24	0.394	14.81	1.384

TABLE 13

Effect of an incomplete milking

Cow 282, pure bred Guernsey; age eight years eleven months; calved February 22, 1923; milked four times per day; July 9, p.m. to July 13, p.m., 1923.

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	11.5	4.01	0.461	5.38	0.619	3.96	0.455	13.35	1.535
	11.2	4.17	0.467	5.47	0.613	4.01	0.449	13.65	1.529
	10.6	4.12	0.437	5.57	0.590	4.10	0.435	13.79	1.462
	11.4	4.39	0.500	5.51	0.628	3.98	0.454	13.88	1.582
	11.2	4.02	0.450	5.50	0.616	3.82	0.428	13.34	1.494
	12.0	4.45	0.534	5.50	0.660	3.86	0.463	13.81	1.657
	11.0	4.05	0.446	5.52	0.607	4.04	0.444	13.61	1.497
	11.5	4.68	0.538	5.50	0.633	4.11	0.473	14.29	1.643
Incomplete milking	5.5	3.35	0.184	5.51	0.303	3.59	0.197	12.45	0.685
Subsequent milkings	15.5	6.67	1.034	5.24	0.812	4.09	0.634	16.00	2.480
	11.6	4.92	0.571	5.37	0.623	3.89	0.451	14.18	1.645
	11.1	4.71	0.523	5.35	0.594	4.03	0.447	14.09	1.564
	11.0	4.26	0.469	5.38	0.592	3.89	0.428	13.53	1.848
	11.0	4.47	0.492	5.43	0.597	3.93	0.432	13.83	1.521
	10.8	4.19	0.453	5.48	0.592	4.03	0.435	13.70	1.480
	10.5	4.50	0.473	5.50	0.578	3.90	0.410	13.90	1.460
	11.3	3.90	0.441	5.38	0.608	3.81	0.431	13.09	1.479
Average preliminary milkings	11.3	4.24	0.479	5.49	0.620	3.98	0.450	13.72	1.549
Average subsequent milkings	11.6	4.80	0.557	5.38	0.624	3.95	0.458	14.13	1.639

TABLE 14

Effect of an incomplete milking

Cow 302, pure bred Holstein; age two years eleven months; calved January 1, 1923; milked four times per day; July 16, p.m. to July 20, p.m., 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		lbs.		lbs.		lbs.		lbs.
Preliminary milkings	12.0	2.66	0.319	5.02	0.602	3.79	0.455	11.47	1.376
	11.9	2.86	0.340	5.11	0.608	3.86	0.459	11.83	1.408
	12.9	2.57	0.332	5.13	0.662	3.69	0.476	11.39	1.469
	12.6	2.84	0.358	5.16	0.650	3.69	0.465	11.60	1.473
	11.8	2.58	0.304	5.02	0.592	3.72	0.439	11.32	1.336
	11.8	2.73	0.322	5.23	0.617	3.71	0.438	11.67	1.377
	12.5	2.61	0.326	5.08	0.635	3.59	0.449	11.28	1.410
	11.4	2.90	0.331	5.13	0.585	3.56	0.406	11.59	1.321
Incomplete milking	5.9	2.19	0.129	5.13	0.303	3.72	0.219	11.04	0.651
Subsequent milkings	15.5	2.86	0.443	5.18	0.803	3.75	0.581	11.79	1.827
	12.5	2.55	0.319	5.12	0.640	3.66	0.458	11.33	1.416
	11.3	2.72	0.307	5.14	0.581	3.64	0.411	11.50	1.300
	11.9	2.66	0.317	5.11	0.608	3.50	0.417	11.27	1.341
	12.4	2.76	0.342	5.18	0.642	3.54	0.439	11.48	1.424
	12.4	2.86	0.355	5.24	0.650	3.59	0.445	11.69	1.450
	11.4	2.94	0.335	5.17	0.589	3.67	0.418	11.78	1.343
	12.3	2.80	0.344	5.19	0.638	3.74	0.460	11.73	1.443
Average preliminary milkings	12.11	2.72	0.329	5.11	0.619	3.70	0.448	11.53	1.396
Average subsequent milkings	12.46	2.77	0.345	5.17	0.644	3.64	0.453	11.58	1.443

TABLE 15

Effect of an incomplete milking

Cow 269, pure bred Jersey; age twelve years; calved July 1, 1923; milked four times per day; July 23, p.m. to July 27, p.m., 1923

	MILK YIELD	FAT		LACTOSE		PROTEIN + ASH		TOTAL SOLIDS	
		Per cent	Yield	Per cent	Yield	Per cent	Yield	Per cent	Yield
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Preliminary milkings	6.3	6.08	0.383	4.72	0.297	3.74	0.236	14.54	0.916
	5.3	5.30	0.286	4.68	0.248	3.53	0.187	13.60	0.721
	5.5	4.40	0.242	4.88	0.268	3.76	0.207	13.04	0.717
	5.5	4.42	0.243	4.86	0.267	3.59	0.197	12.87	0.708
	5.7	4.99	0.284	4.88	0.278	3.41	0.194	13.28	0.757
	5.3	6.47	0.343	4.89	0.259	3.21	0.170	14.57	0.772
	4.9	5.20	0.255	4.87	0.239	3.40	0.167	13.47	0.660
	5.1	5.72	0.292	5.85	0.247	3.44	0.175	14.01	0.715
Incomplete milking	2.7	4.34	0.117	4.86	0.131	3.55	0.096	12.75	0.344
Subsequent milkings	7.1	5.98	0.425	4.76	0.338	3.28	0.233	14.02	0.995
	5.2	5.31	0.276	4.68	0.243	3.46	0.180	13.45	0.699
	5.1	4.52	0.231	4.79	0.244	3.41	0.174	12.72	0.649
	5.1	6.45	0.329	4.69	0.239	3.49	0.178	14.63	0.746
	4.2	5.83	0.245	4.84	0.203	3.24	0.136	13.91	0.584
	5.0	5.46	0.273	5.00	0.250	3.47	0.174	13.93	0.697
	4.4	4.16	0.183	4.94	0.217	3.50	0.154	12.60	0.554
	4.2	5.13	0.215	4.93	0.207	3.62	0.155	13.68	0.575
Average preliminary milkings	5.45	5.34	0.291	4.82	0.263	3.52	0.191	13.68	0.745
Average subsequent milkings	5.04	5.40	0.272	4.82	0.242	3.43	0.173	13.65	0.687

TABLE 16

Number of cows showing a significant average increase or decrease in the percentage fat, lactose, and protein + ash contents and the yields of fat and milk

	MILK YIELD	FAT		LACTOSE	PROTEIN + ASH
		Yield	Per cent	Per cent	Per cent
	lbs.	*lbs.*			
Trial I—4 cows (A):					
Number increased	1	2	2		2
Number decreased				3	
Trial II—3 cows (B):					
Number increased	1	3	3		
Number decreased	1			2	1
Trials III to X—8 cows (C):					
Number increased	3	4	4		2
Number decreased			2	3	1

* A significant average increase or decrease was considered as not less than 0.1 per cent for percentages, 0.7 pounds for yield of milk, and 0.03 pounds for yield of fat.

(A) Cows milked 2 times per day, one-fourth of average milk yield left in udder.

(B) Cows milked 2 times per day, one-half of average milk yield left in udder.

(C) Cows milked 4 times per day, one-half of average milk left in udder.

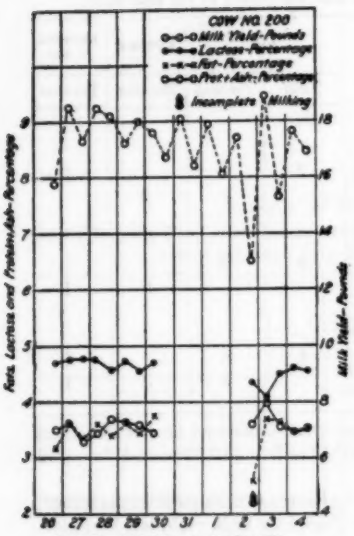
TABLE 17

Comparison of the grand averages of all the average increases or decreases in the respective percentage fat, lactose, and protein + ash contents and the yields of fat and milk, as determined for each trial

	MILK YIELD	FAT		LACTOSE	PROTEIN + ASH
		Yield	Per cent	Per cent	Per cent
	lbs.	*lbs.*			
Trial 1 (A), tables 1 to 4, inclusive:					
Average increase*	0.43	0.048	0.17	0.05	0.08
Average decrease*	0.46			0.22	
Trial 2 (B), tables 5 to 7, inclusive:					
Average increase*	0.76	0.064	0.40		
Average decrease*	0.74			0.20	0.10
Trials 3 to 10 (C), tables 8 to 15, inclusive:					
Average increase*	0.72	0.041	0.28	0.07	0.10
Average decrease*	0.41	0.019	0.13	0.14	0.05

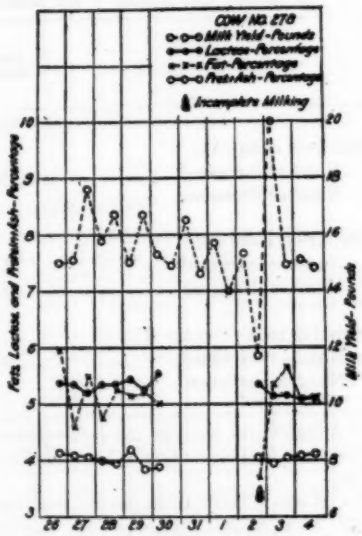
* These figures represent the grand average of all the increases or decreases, which are due to differences between the averages of the respective percentage contents and yields. The averages of these respective percentage contents and yields being determined from the preliminary and subsequent milkings reported in the tables included in each trial.

(A), (B), (C) See table 16.



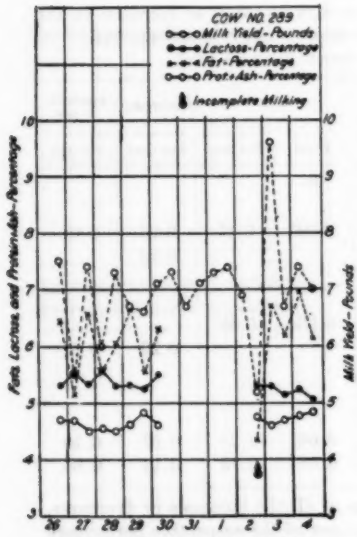
Date-March 26, P.M. to April 4, P.M. 1923

Fig. No. 1



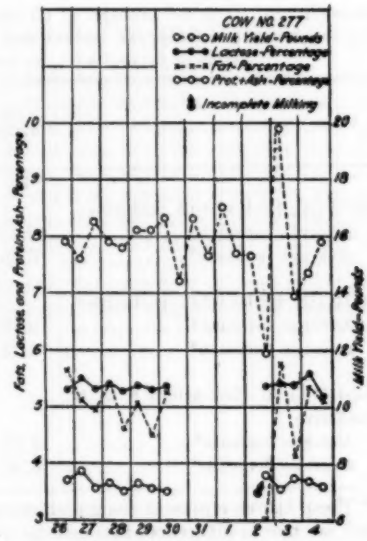
Date-March 26, P.M. to April 4, P.M. 1923

Fig. No. 3



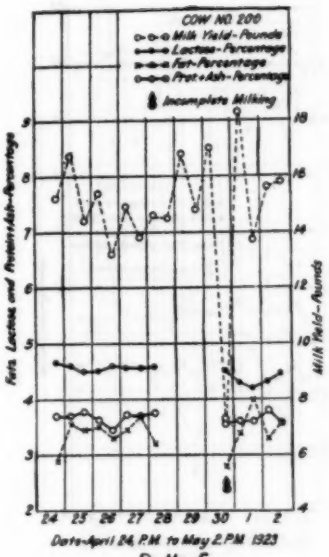
Date-March 26, P.M. to April 4, P.M. 1923

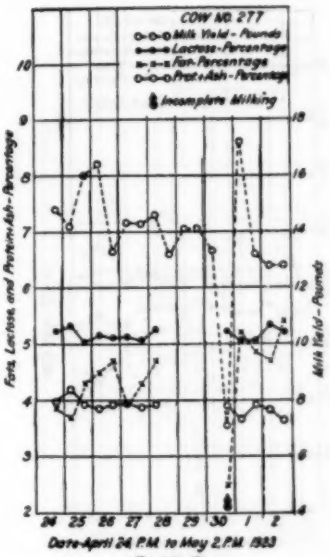
Fig. No. 2

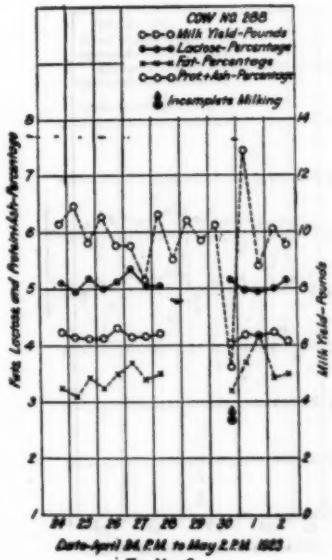


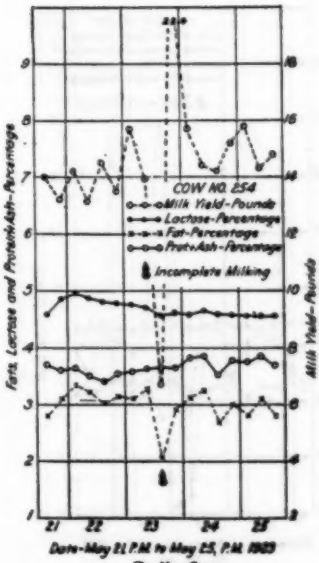
Date-March 26, P.M. to April 4, P.M. 1923

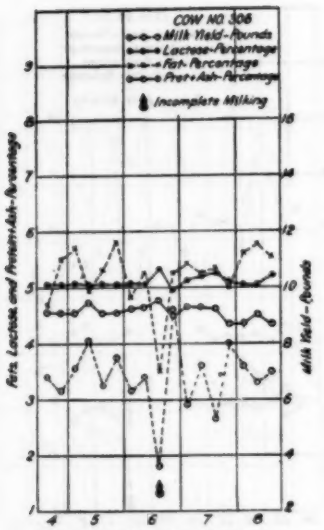
Fig. No. 4

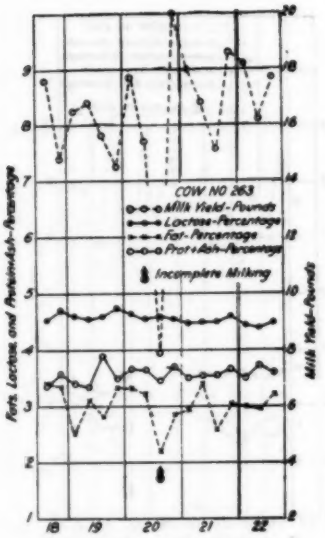

COW NO. 209
Milk Yield - Pounds
Lactose - Percentage
Fat - Percentage
Prot + Ash - Percentage
Incomplete Milking
Fats, Lactose and Protein+Ash - Percentage
Milk Yield - Pounds
24 25 26 27 28 29 30 1 2
Date - April 24, P.M. to May 2, P.M. 1923
Fig. No. 5

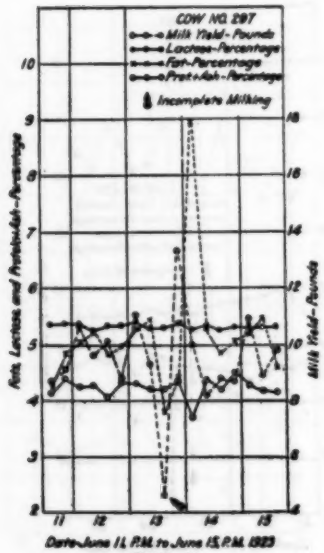

COW NO. 277
Milk Yield - Pounds
Lactose - Percentage
Fat - Percentage
Prot + Ash - Percentage
Incomplete Milking
Fats, Lactose and Protein+Ash - Percentage
Milk Yield - Pounds
24 25 26 27 28 29 30 1 2
Date - April 24, P.M. to May 2, P.M. 1923
Fig. No. 7

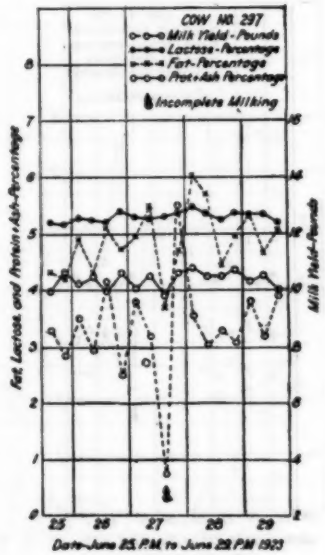

COW NO. 288
Milk Yield - Pounds
Lactose - Percentage
Fat - Percentage
Prot + Ash - Percentage
Incomplete Milking
Fats, Lactose and Protein+Ash - Percentage
Milk Yield - Pounds
24 25 26 27 28 29 30 1 2
Date - April 24, P.M. to May 2, P.M. 1923
Fig. No. 6

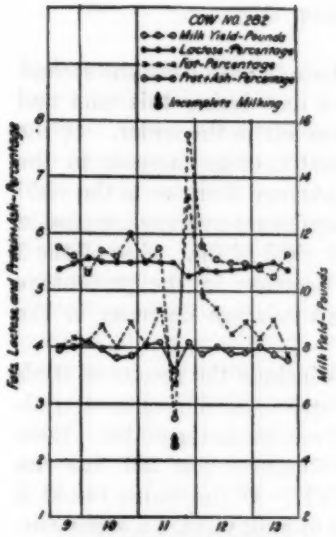

COW NO. 254
Milk Yield - Pounds
Lactose - Percentage
Fat - Percentage
Prot + Ash - Percentage
Incomplete Milking
Fats, Lactose and Protein+Ash - Percentage
Milk Yield - Pounds
21 22 23 24 25
Date - May 21, P.M. to May 25, P.M. 1923
Fig. No. 8

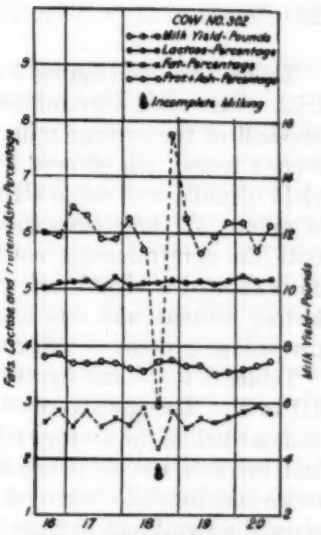

COW NO. 306
Milk Yield - Pounds
Lactose - Percentage
Fat - Percentage
Prot + Ash - Percentage
Incomplete Milking
Fats, Lactose, and Protein + Ash - Percentage
Milk Yield - Pounds
Date - June 4, P.M. to June 8, P.M. 1923
Fig. No. 9

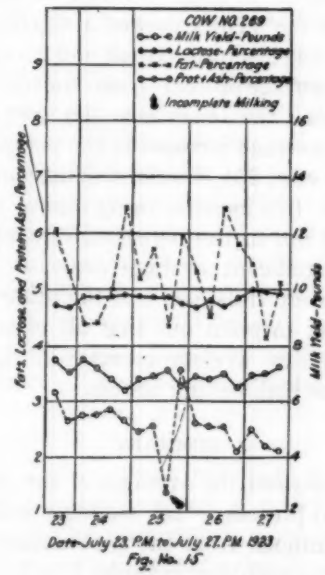

COW NO 263
Milk Yield - Pounds
Lactose - Percentage
Fat - Percentage
Prot + Ash - Percentage
Incomplete Milking
Fats, Lactose, and Protein + Ash - Percentage
Milk Yield - Pounds
Date - June 18, P.M. to June 22, P.M. 1923
Fig. No. 11


COW NO. 297
Milk Yield - Pounds
Lactose - Percentage
Fat - Percentage
Prot + Ash - Percentage
Incomplete Milking
Fats, Lactose, and Protein + Ash - Percentage
Milk Yield - Pounds
Date - June 11, P.M. to June 15, P.M. 1923
Fig. No. 10


COW NO. 297
Milk Yield - Pounds
Lactose - Percentage
Fat - Percentage
Prot + Ash Percentage
Incomplete Milking
Fat, Lactose, and Protein + Ash - Percentage
Milk Yield - Pounds
Date - June 25, P.M. to June 29, P.M. 1923
Fig. No. 12


COW NO. 282
Milk Yield - Pounds
Lactose - Percentage
Fat - Percentage
Prot + Ash - Percentage
Incomplete Milking
Fats, Lactose and Protein+Ash - Percentage
Milk Yield - Pounds
Date - July 9, P.M. to July 13, P.M. 1923
Fig. No. 13


COW NO. 302
Milk Yield - Pounds
Lactose - Percentage
Fat - Percentage
Prot + Ash - Percentage
Incomplete Milking
Fats, Lactose and Protein+Ash - Percentage
Milk Yield - Pounds
Date - July 16, P.M. to July 20, P.M. 1923
Fig. No. 14


COW NO. 289
Milk Yield - Pounds
Lactose - Percentage
Fat - Percentage
Prot + Ash - Percentage
Incomplete Milking
Fats, Lactose and Protein+Ash - Percentage
Milk Yield - Pounds
Date - July 23, P.M. to July 27, P.M. 1923
Fig. No. 15

Tables 5 to 7 and figures 5 to 7 include the results of the second trial. The cows were milked twice a day during this trial and one-half of the average milk yield was left in the udder. Of the 3 cows tested, one showed a significant average increase in the yield of milk, and one a significant average decrease in the yield of milk. All three cows showed a significant average increase in both the percentage fat content and yield of fat. Two of the 3 cows showed a significant average decrease in the percentage lactose content, and one a significant average decrease in the percentage protein + ash content.

Tables 8 to 15 and figures 8 to 15 include the results of trials III to X. The cows were milked 4 times a day during these trials and one-half of the average milk yield was left in the udder. Each trial involved the use of one cow, the Guernsey cow 297 was run twice once in trial V and once in trial VII. Of the 8 cows tested, 3 showed a significant average increase in milk yield, 4 a significant average increase in both the percentage fat content and yield of fat, and 2 a significant average decrease in the percentage fat content. Three of the 8 cows showed a significant average decrease in the percentage lactose content and 2 a significant average increase in the percentage protein + ash content. The Guernsey cows 282 and 297 and the Jersey cow 306 were the only cows to show a significant average increase in the percentage fat content. Only one Holstein cow, 254, showed a significant average increase in the yield of fat, this increase being due to a large increase in the milk yield and not in the percentage fat content. Of the 3 cows showing a significant average decrease in the percentage lactose content, 2 were Holsteins and the other a Guernsey. It might be of interest to point out that all cows in trials III to X showing a significant average increase in the percentage fat content were of the high testing breeds.

SUMMARY

The difference between the averages of the respective percentage fat lactose and protein + ash contents and the yields of fat and milk, as determined from the preliminary and subsequent milkings reported for each cow in tables 1 to 15, are in most cases

not very great. There is, however, a general trend in these differences (table 17) which indicates that they are due to the presence of some common disturbing factor, that factor being the leaving of milk within the udder. The differences in the percentage lactose and protein + ash contents are for the most part not as great as those found in the percentage fat content and yields of fat and milk. On the other hand the extent of the variation within the percentage fat content and yields of fat and milk, as measured from one milking to another, figures 1 to 15, is on the average more than twice as great as the equivalent variation within the percentage lactose and protein + ash contents. Hence taking into consideration the degree of variation as measured from one milking to another, it is obvious that comparatively smaller differences in the percentage lactose and protein + ash contents are just as significant as larger differences in the percentage fat content and yields of fat and milk.

Considering the averages of all the increases and decreases in the respective percentage fat, lactose, and protein + ash contents and the yields of fat and milk, as determined for each trial (table 17), it will be found that the average of all the increases and decreases in trial II is greater than the average of all the increases and decreases in trials I or trials III to X. This difference in the averages of all the increases and decreases in the percentage contents and yields as found in the various trials can be attributed to the influence of one of two factors; namely, (1) the amount of milk left in the udder; and, (2) the length of time the milk is left in the udder. In trials I and II the cows were milked twice a day, but in trial 1 one-fourth of the average milk yield was left in the udder, whereas in trial II one-half of the average milk yield was left in the udder. Hence by increasing the amount of milk left in the udder, the effect upon the percentage fat, lactose and protein + ash contents and the yields of fat and milk was increased. In trials III to X the cows were milked 4 times a day and one-half of the average milk yield was left in the udder. In trials III to X the same amount of milk was left in the udder as in trial II, but the milk remained in the udder only 6 hours in trials III to X as compared to twelve hours in trial II. We

find that the average of all the increases and decreases in the various percentage contents and yields in trials III to X is less than the equivelant average in trial II, the decrease being due to the shortening of the length of tine the milk was left in the udder.

The number of cows in each trial showing a significant average increase or decrease in the percentage fat, lactose, and protein + ash contents and the yields of fat and milk (table 16) also manifest the influence of the above mentioned factors in each trial. Trial I included 4 cows and each cow had the opportunity of showing a significant average increase or decrease in the percentage fat, lactose, and protein + ash contents and the yields of fat and milk. If each cow in every trial showed a significant average increase or decrease in every percentage content and yield, there would be 20 significant averages increase or decreases in trial I, 15 significant average increases or decreases in trial II and 40 significant average increases or decreases in trials III to X. Hence the ratio of the actual number of significant average increases or decreases to the total possible number of significant average increases or decreases in each trial will give the amount of disturbance in the various percentage contents and yields due to the leaving of milk within the udder. In trial I we find 10 actual significant average increases or decreases out of a possible 20 significant average increases or decreases, a ratio of 1:1. In trial II we find 10 significant average differences out of a possible 15 significant average differences, a ratio of 2:1. In trails III to X we find 19 actual significant average differences out of a possible 40 significant average differences, a ratio of less than 1:1. Trial II again stands out as showing the most marked disturbance in the various percentage contents and yields due to the amount of milk left in the udder and the length of time it was left in the udder.

CONCLUSIONS

The effect of an incomplete removal of milk from the udder on the quantity and composition of the milk produced during the subsequent two-day period is as follows:

1. The average yield of milk and fat, and the average percentage of fat in the milk tends to increase for the two days following an incomplete milking.

2. The average percentage of lactose in the milk tends to decrease for the two days following an incomplete milking.

3. The average percentage of protein + ash in the milk is changed only very slightly during the two days following an incomplete milking.

4. The degree of change in the composition of the milk produced during the two days following an incomplete milking is influenced by two factors, (a) the amount of milk left in the udder at the incomplete milking, and (b) the length of time the milk is left in the udder, i.e. the length of time elapsing between the incomplete milking and the first succeeding dry milking.

5. The decrease in the percentage of lactose in the milk at any milking during the two days subsequent to an incomplete milking is not sufficient to permit the use of a sugar determination as a detective measure. Such a decrease, however, may be sufficient to justify suspicion.

6. The changes in the composition of the milk produced during the two days following an incomplete milking are not in themselves sufficient to be used as a detective measure without some knowledge of the composition of the milk produced previous to the incomplete milking.

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VITAMINES IN DAIRY PRODUCTS

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Before discussing vitamins it is necessary to know something of the history and nature of vitamins. The name, vitamine, traces back to 1911 when Casimir Funk applied the name to substances that had some curative properties for that dreaded Oriental disease known as beri-beri. This was a disease very common in the Orient where the diet consisted of polished rice. The cause and cure of the disease had never really been understood by the medical men.

Since 1911 many of the best chemists and research men have been working on vitamins and much new information on the subject has been obtained. The scientific and chemical journals have had many articles bearing on the subject, but, as yet, the exact chemical nature of vitamines remains to be determined. At the present time there are three known vitamins necessary for health and growth with two undetermined, one of which prevents rickets, while the other has a marked influence on reproduction. The three vitamins have been named fat solubleA, water soluble B, and water soluble C. The first, as its name implies, accompanies the fat portion of the extracts of cells and tissues; it is the substance necessary for growth and it appears to be the substance that prevents the diseases of rickets and xeropthalmia. It is found most abundantly in milk, eggs, cod liver oil, and in green leaves. The second, or water soluble B, is the substance which protects against neuritis and if absent in the food, beri-beri results. It is found in yeast, in grains and cereals. The third is water soluble C, and is the vitamine that prevents scurvy (1).

Table showing the distribution of the vitamins A, B and C in the common food-stuffs (2)

XXXX means very plentiful; XXX abundant; XX relatively large amount X present in small quantities; 0 absent; (?) not definitely proved.

	A	B	C
	Foodstuffs		
Meats:			
Beef heart	X	X	(?)
Brains	XX	XXX	X(?)
Codfish	X	X	(?)
Fish roe	X	XX	(?)
Herring and salmon	XX	XX	(?)
Horse meat	X	X	
Kidney	XX	XX	
Lean meat	X	X	X
Liver	X	X	(?)
Sweetbreads	0	XXX	0
Tinned meats	(?)	Very slight	0
Vegetables:			
Beet root	X	X	XX
Beet root juice	(?)	X	XXX
Cabbage, dried	XXX	XXX	X
Cabbage, fresh	XXX	XXX	XXXX
Carrots	XXX	XXX	XX
Cauliflower	XX	XXX	XX
Celery	(?)	XXX	(?)
Chard	XXX	XX	(?)
Dasheens	X	XX	(?)
Lettuce	XX	XX	XXXX
Mangels	XX	XX	(?)
Onions	(?)	XXX	XXX
Parsnips	XX	XXX	
Peas (fresh)	X	XX	XXX
Potatoes	0	XXX	XX
Potatoes (sweet)	XXX	XX	(?)
Rutabaga		XXX	
Spinach	XXX	XXX	XXX
Cereals:			
Barley	X	XXX	(?)
Bread (white)		X(?)	
Bread (whole meal)	X	XXX	(?)
Maize, yellow	X	XXX	(?)
Maize, white	0	XXX	(?)
Oats	X	XXX	0
Rice, polished	0	0	0

	A	B	C
Foodstuffs—*Continued*			
Rice, whole grain	×	×××	0
Rye	×	×××	0
Corn embryo		×××	
Malt extract	0	0	0
Wheat bran	0	×	0
Wheat embryo	××	×××	0
Wheat kernel	×	×××	0
Other Seeds:			
Beans, kidney		×××	
Beans, navy		×××	0
Beans, soy	×	×××	0
Cotton seed	××	×××	
Flaxseed	××	×××	
Hempseed	××	×××	0
Millet seed	××	×××	0
Peanuts	×	××	
Peas (dry)	×(?)	××	0
Sunflower seeds	×		
Fruits:			
Apples		××	××
Bananas	(?)	×	××
Grapefruit		×××	×××
Grape juice		×	×
Grapes	0	×	×
Lemons	0	×××	××××
Limes		××	××
Oranges		×××	××××
Pears		××	××
Raisins		×	×
Tomatoes	××	×××	××××
Tomatoes, canned			×××
Oils and Fats:			
Almond oil	0	0	
Beef fat	×	0	0
Butter	××××	0	0
Cocoanut oil	0	0	0
Codliver oil	××××	0	0
Corn oil	××××	0	0
Cotton seed oil	0(?)	0	0
Egg yolk fat	0	0	0
Fish oils	××	0	0
Lard	0	0	0
Oleo, animal	×	0	0

	A	B	C
Foodstuffs—*Continued*			
Oleo, vegetable	0	0	0
Olive oil	0	0	0
Pork fat	0(?)	0	
Tallow	0	0	0
Vegetable oils	0(?)	0	0
Nuts:			
Almonds	×	×××	
Brazil nut		××××	
Chestnut		×××	
Cocoanut	××	×××	
English walnuts		×××	
Filbert		×××	
Hickory	×	×	×
Pine	×	×	×
Dairy products			
Butter	××××	0	0
Cheese	××	×	(?)
Cream	×××	×	(?)
Eggs	××××	××	0
Milk, condensed	××	×	0
Milk powder, skim	×	×××	×(?)
Milk powder, whole	×××	×××	×(?)
Milk, whole	×××	×××	××
Whey	×	×××	×
Miscellaneous			
Alfalfa	×××	×××	(?)
Blood	Varies with sources		
Clover	×××	××××	(?)
Honey		××	0
Malt extract	0	0	0
Meat extract	0	0	0
Timothy	××	×××	0
Yeast brewers	0	××××	0
Yeast cakes	0	××	0
Yeast extract (Vegex)	0	××××	0

THE ANTI BERI-BERI VITAMINE OR WATER SOLUBLE B

The disease beri-beri has been studied for a long time as it has been very prevalent in the Oriental countries. In Japan the disease was prevalent among the sailors whose diet consisted chiefly of polished rice. Professor Eijkman, in 1897, while caring for prisoners on the Island of Java discovered that chickens fed the boiled polished rice developed the disease beri-beri, which disease caused a numbness followed by edema and cramps of the legs. As the disease advances, partial paralysis takes place and edema becomes more general.

After the Philippines had been acquired by the United States, a medical commission was sent to investigate the conditions and study causes of the disease. After their report, which stated that a faulty diet caused beri-beri, due to the large consumption of polished rice, a law was passed prohibiting the use of polished rice in public institutions and the result was a reduction in the number of patients suffering with the disease. They found that the cortex of the rice grain was curative to beri-beri, and therefore must contain the necessary element. However, no definite name was given to the lacking element, nor was any theory set forth as to the exact cause (2).

In 1906, F.G. Hopkins, who has done very good work on vitamins, concluded from his work with experimental animals that something besides the ordinary nutrients was necessary for growth. He concluded the following from the nutritive work he had done with rats: "No animal can live upon a mixture of pure protein, fat and carbohydrate and organic salts. The animal body is adjusted to live either upon plant tissues or other animals and these contain countless substances other than carbohydrates, proteins and fats" (2).

Fraser and Stanton found that an alcohol extract from rice polishings could be made into a concentrated curative for beriberi.

None of the above named men advanced any theory to account for these phenomena and it remained for Casimir Funk, who worked with fractional extracts testing their value on poly-

neuritic birds. He finally obtained a crystalline substance with high curative properties. He called it vitamine, vita, meaning necessary for life, and amine because it contained nitrogen and he believed it to be one of the amino acids.

The Japanese chemist, Suzuki, at the same time as Funk came out with his results, accomplished about the same, but his work had been going on a little longer, thus his work really preceded Funk's. Other workers soon proved Suzuki's and Funk's vitamine crystals to be impure compounds, and it still remains for someone to determine the exact chemical nature of this vitamine. However, the word vitamine still remains as the name of the curative substance. Osborne and Mendel did the first work on dairy products. They were conducting researches in nutrition of a single purified protein supplemented with fat, carbohydrates, and minerals salts, in such quantities and proportions that the required number of calories was always present. They found that no matter how well proportioned the mixture might be in all the known nutrient requirements, the rats failed to grow unless there were added small amounts of milk. In their work they further discovered that the substances in the milk were distributed in two different parts of the milk, namely the butterfat and in the protein and fat free whey. When either of these ingredients were left out of the diet, the rats ceased to grow. No explanation could be found for this phenomena until Funk published his vitamine hypothesis, when it was immediately linked up with nutrition (2).

During this same period many other experimenters had been working along nutritional lines and the year 1911 became significant in that many of the unexplained phenomena in nutrition could be linked up and explained by the Funk vitamine hypothesis. It is from this date on that the greatest strides in nutrition have been taken.

McCollum's work at Wisconsin showed that egg yolk fat contained the same substance as butterfat, and he named this mysterious factor, vitamine fat soluble A.

Water soluble C, or the antiscorbutic vitamine prevents scurvy. The absence of this substance from the diet has been

studied for a long period. In 1400, cabbage soup was known to prevent scurvy when it was shown that 20 men out of 1400 developed the disease because they refused to eat cabbage soup in a prison camp. As early as 1600, English seamen received rations of lemon juice to prevent scurvy. In 1747 Dr. Lind, a surgeon on the British sailing vessel, Salisbury, proved that lemons and oranges would effect a cure for scurvy. In 1775, cabbage and spinach were known as antiscorbutics, but that their curative factor was lost on drying (2).

In 1912, Holst and Frohlich began the study of scurvy which ended in the discovery of a vitamine which was called vitamine water soluble C. Dr. McCollum also worked on scurvy, and in 1918, stated that scurvy was not due to the lack of a vitamine in the diet, but to the absorption of toxins from the intestines, due to protein putrefaction and constipation. His explanation did not agree with other investigators who held to the vitamine hypothesis. He was attacked by many of the investigators in England, and especially by Osborne and Mendel, in America. As time went on, the findings of McCollum were proved erroneous because the injection of orange juice intravenously showed the same curative powers as if ingested. It was also proven that milk contained the factor in question by showing vitamine A and B to be non-antiscorbutic. The vitamine was water soluble like B, but otherwise had different properties.

The proof of the existence of the three vitamines is found in the summary of Prof. F. G. Hopkins researches in physiological chemistry covering fifteen years of his work, which reads as follows: "The absence of one particular vitamine from the food is the whole and sufficient cause of human scurvy, the absence of another forms the main factor in the etiology (cause) of beriberi (general, neuritis), the absence of a third plays at least a large part in the induction of rickets."

But with the opening up of this new field of research calling for entirely new methods, much contradictory literature has been published, due to inaccurate observations, too limited data and the wrong interpretation of results (3).

Up to 1920 it was thought that rickets was caused by deficiency in vitamine A, but since then it has been studied more thoroughly. Dr. Hess has suggested tht there is another vitamine that prevents rickets.

C. H. Hunt has more recently studied this last named deficiency disease. He worked with cod liver oil and butter fat and has observed that if cod-liver oil is administered, rickets will not develop in spite of the fact that the diet is low in calcium mineral. Evidently there is something in cod liver oil that prevents rickets under unfavorable conditions. This substance has been provisionally called vitamine D. Butter does not seem to have this anti-rickets vitamine present to any great extent but if the diet contains plenty of mineral matter, then butter will serve the purpose as well as cod liver oil.

He further observed that rays of light that come direct from the sun have activating energy, but not after passing through glass. These direct rays prevent and cure rickets (4).

The latest research experiments have been conducted to discover the reason for sterility in rats. It was observed that rats could be reared and grow normally but can not reproduce on a so called basic ration consisting of 18 per cent casein, 54 per cent cornstarch, 15 per cent lard, 9 per cent milkfat, and 4 per cent salts to which daily doses of 0.4 to 0.5 gram of dried whole yeast is added. The rats may exhibit normal oestrus and ovulation and conceive. The placentae are abnormal and the products of conceptions are invariably resorbed. Ordinarily the natural foodstuffs contain a substance, *X*, which prevents such a sterility or cures it if it has been established. By feeding green leaves, fresh meat or cereals, fertility will be restored.

In some cases the favorable results were obtained when the latter foods were added to the basic rations after ovulation and fertilization had occurred "so that presumptive evidence is secured of normal germ cells but defective uterine function as the specific cause of the disease. Yet the occurrence of the disease in males shows that in this sex the germ cells are diseased and this possibly also is the case in females."

Here again this substance, *X*, was found to be present in milk fat though in very small amounts, and to restore fertility the diet must be made up of 24 per cent butterfat. Fertility may be restored by increasing the amount of unextracted commercial casein.

This new factor is distinct from "vitamine A" since it was found to be very low in a certain lot of cod-liver oil of proved high "vitamine A" content, and, furthermore the dietary placental disease does not occur when "A" quota is lower than in our basic ration, providing *X* be present. The water-soluble vitamine "B" cannot be concerned since when vitamine "B" is increased by high yeast dosage or additional daily feeding of 10 cc. of fresh milk, the disease is not affected. Vitamine "C" seems definitely eliminated by the ineffectual outcome of daily fresh orange juice dosage and by the effectual results of cereals notoriously low in or devoid of "C." The new dietary *X* can be extracted by alcohol and ether from the curative foods. Studies are being conducted on the characteristics of this factor indispensable for reproduction and on its further distribution in natural foods (5).

From the varied results obtained by many different investigators it would seem that other factors enter in besides experimental errors.

The vitamins were from several substances and collected at different seasons of the year. Recently it has been conclusively proved that the season of the year has had a marked influence on the vitamine content of milk.

To the last named factor many of the conflicting results may be traced. As early as 1916, McCollum, Simmonds, and Fitz had reached the conclusion that vitamins A and B passed in to the the milk only as they were present in the diet of the cow. In 1918, Steenboch, Boutwell, and Kent observed that butterfat varied, and assumed that the ration of the cow might be faulty. Each year has brought out new facts throwing more light on the subject so that at the present time it has been conclusively proved that the A, B and C vitamine content of the food fed to the cow determines the A, B and C vitamine content of the milk (8). C. H. Hunt concluded from experiments conducted at Ohio Agricultural Experiment Station that the milk of cows on green pasture is richer in vitamine C than milk from cows on

dry feed (4). Kennedy and Dutcher showed in their work that vitamins A and B were dependent upon the vitamine content of the ration but showed that it was possible to produce a vitamine-rich milk in the winter by the proper choice of feeds (8).

It has been found that vitamine A is closely associated with carotinoids or the yellow pigment found in plants. It has been proven that yellow corn contains more of the vitamine A than the white corn. However, this should not be taken to mean that a highly yellow colored food is rich in vitamine A, but in some cases it may be taken as an indication as has been shown for yellow corn (4).

Other factors that affect the vitamine content are preservatives, alkalies and heat.

Sodium bicarbonate, or baking soda will destroy vitamine B, but when it is combined with buttermilk or tartaric acid the alkali is neutralized and the vitamins are protected (2).

Vitamine A is gradually lost by oxidation and for that reason butter which is a very good source of vitamine A, gradually loses its vitamine when exposed to oxidation and the same holds true of cod liver oil in the process of refining (2).

The greatest loss in vitamins takes place through heat. Drying most foods destroys the C vitamins and boiling for a long period tends to destroy all of vitamine C. Most authors agree that vitamine C is destroyed in milk by pasteurizing at 145°F. for 30 minutes. However, this still remains to be satisfactorily proved.

Feeding experiments have been carried on to determine how the fat soluble A vitamine and water soluble B are affected by heating. The C vitamine, or the antiscorbutic vitamine, is not necessary for growth in mice as it can be synthesized by them. Milk was autoclaved at 10 and 15 pounds pressure for fifteen minutes and fed to growing mice which had been fed for a period of about fifteen days on a diet devoid of vitamins, but complete in respect to protein, carbohydrates, fats and minerals.

The conclusions of the experiments were that the fat soluble A and the water soluble B of milk autoclaved at 10 and 15 pounds pressure for 15 minutes were not affected to any appreciable extent when fed as a source of vitamins (6).

VITAMINS IN CONDENSED AND DRIED MILKS

Hess and Hume state that sweetened condensed milk retains practically all of its vitamine C, and Daniels and Laughlin show that sweetened evaporated or sweetened condensed milk had sufficient supply of A and B vitamins to support normal growth (7).

Cornelia Kennedy concluded from experiments with Spray and Drum process of drying milk that Vitamine B was not affected by either process but "that the vitamine A content of drum dried milk more nearly approximates the original milk in this respect than does milk dried by the Spray process; and that in both kinds of dried milk a change in the vitamine content may be expected which corresponds to changes found in fresh milk, due to seasonal changes in the feed of the cow." She further concluded that milk powders vary in their content of vitamine C according to the process used in preparation. The period of exposure to heat and oxidation is less during the drum drying process and the result is that less of the vitamine C is destroyed. It was found that milk so processed still contains enough of its antiscorbutic properties to protect babies and experimental animals from scurvy (7).

There are still many undetermined factors that influence vitamins which will have to be studied more carefully.

One of the more important factors that has been worked on and is still under experimentation is the effect of pasteurization on vitamine C. Some authors maintain that it is destroyed while others have concluded that it has only been partially destroyed.

For the chemist it still remains to isolate and determine the chemical nature of vitamins. At the present time all that is known about vitamins is that their presence is essential to normal growth and health.

One thing has been definitely proved, that milk does contain three important vitamins though varying in amount due to variations in vitamine content of the rations fed to the cows. Butter is one of the best sources of vitamine A; cream contains both A and B; cheese A and B; powdered milk contains both A and B, also C although not in very large amounts.

From the above facts, milk and dairy products should be used more extensively in the diet to furnish not only the nutrients but the vitamins without which, proper growth and health will not be obtained.

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REVIEW OF FOREIGN DAIRY LITERATURE

R. C. FISHER

Connecticut Agricultural College

VAN DER BURG, B., L.i., Laboratory of Dairy Manufacturing and Dairy Science of the College of Agriculture, Wageningen, Holland. Determination of the Per Cent of Salt in Cheese. As published in the Journal of Microbiology and Hygiene of Comparative Tropical Medicine of Parasitic and Infectious Diseases, vol. ix, no. 3.

In this paper the author calls attention to the fact that salt plays a very important rôle in cheese. He explains, that salt exerts not only a direct influence on the flavor of cheese, but that it also indirectly affects it, by producing a preferential media for certain microörganisms. The microörganisms occurring in freshly made cheese vary as to their sensitiveness to a certain per cent brine solution. By this means, cheese ripening is controlled through the per cent of salt in the moisture of the cheese or in other words the concentration of the salt brine.

In the third place, according to the author, salt also exerts an influence on the body and texture of the curd, as the readiness with which the paracasein absorbs and retains moisture, besides depending on the acidity, is also dependent, as shown by Van Dam, on the concentration of the salt. In view of these important influences of salt on flavor, ripening and physical properties of the cheese, it seemed to the author that there is need for a simple and practical determination of the per cent of salt to replace or supplement the present rather complicated and expensive test.

With this in mind and at the request of one of the large Associations of Cheese Factories, he proposes the following test for salt in cheese:

Sample of cheese is taken in the usual manner and ground fine in a small meat grinder.

After thoroughly mixing, 4 grams of the grated cheese is placed into a 100-cc. measuring flask. About 50 to 60 cc. of warm water and 10 cc. of approximately 0.1 N alkali is added. The mixture is shaken at intervals until the cheese is completely dissolved. It is then allowed to cool to room temperature, when 10 cc. of nitric acid (6 N specific gravity 1.2) is added. Water is then added up to the mark. After thorough mixing, it is filtered through a dry filter; 50 cc. of the filtrate measured

out, to which is added 15 cc. of 0.1 N silver nitrate solution. The excess silver is (without filtering off the formed silver chloride) retitrated with 0.1 N sulfo cyanate of ammonium (NH_4 CNS) using 1 cc. of saturated solution of ferric ammonium sulphate as an indicator. The number of cubic centimeters of silver nitrate solution used minus the amount required for a blank trial, multiplied with 0.2925 gives the per cent of salt in cheese. The correction for the blank determination cannot be

TABLE 1

Comparative results of the modified V. D. Burg test and the ash determination for salt in cheese.

SAMPLE NUMBER	METHOD (V. D. BURG)	ASH DETERMINATION	SAMPLE NUMBER	METHOD (V. D. BURG)	ASH DETERMINATION
1	3.05	2.99	4	1.75	1.81
	3.05		5	2.05	2.12
	3.10		6	2.15	2.14
	3.05		7	1.70	1.78
	3.05		8	2.0	2.0
	3.10		9	1.85	1.96
			10	1.75	1.75
2	2.95	2.95	11	1.60	1.69
	2.95	3.01	12	1.75	1.79
	2.95		13	1.40	1.39
	2.95		14	1.85	1.96
	2.95		15	1.95	1.96
			16	1.90	1.94
3	3.25	3.23	17	1.75	1.76
	3.25	3.23	18	1.90	1.92
	3.15	3.22	19	1.85	1.84
	3.15	3.21			
	3.15	3.23			
	3.15	3.21			
	3.15	3.21			
	3.15	3.21			
	3.15	3.21			
	3.15	3.22			

neglected because the alkali used may contain chlorine. To simplify the calculation one can weigh out 3.9 grams instead of 4 grams. In this case the per cent of salt in the cheese is arrived at by multiplying the cubic centimeters of silver nitrate solution with 0.3.

The author has compared the above test with regular ash determination and in table 1, reports the results of the comparison.

The conclusions of the author are that the comparative results as shown in table 1, indicate that the salt content is determined with sufficient accuracy by use of the much simpler titration method.

HEKMA, E., Director of the Division of Physiology. Is Fibrin a Physiological Constituent of Normal Milk? 1922 Annual Report of the Agricultural Experiment Station, Hoorn, Netherlands.

In the course of the experiments regarding the process of milk curdling it appeared that under the influence of rennet and acids, delicate threads occur in milk, which participate in the micro structural formation of the coagulation and are very similar to fibrin threads. As a result of this observation the probability of the occurrence of fibrin in normal milk was subjected to an exhaustive test. Consideration was given to the various forms in which fibrin may occur especially the dissolved, the optically negative and the filament state.

In order to test the milk for the presence of fibrin, blood serum and a saturated solution of table salt was used as one test, and the dark field analysis according to the fibrin coloring test of Weigert as still another test.

Fibrin was not found to occur in normal milk, neither in the dissolved nor in the filament state. Consequently lt is not permissible to consider the previously mentioned threads, occurring during the process of curdling, as fibrin. Neither can fibrin participate in the creaming process of milk; even although in the course of the experiment the facts showed that the creaming process may be materially favored by blood serum.

Moreover the fact becomes established that the fibrin cannot be looked on as physiological constituent of milk, henceforth any milk in which fibrin is found should be considered as abnormal, even although this abnormality not necessarily need be considered synonym with unfitness.

Nevertheless such milk should at the same time be subjected in other respects to a thorough test for fitness.

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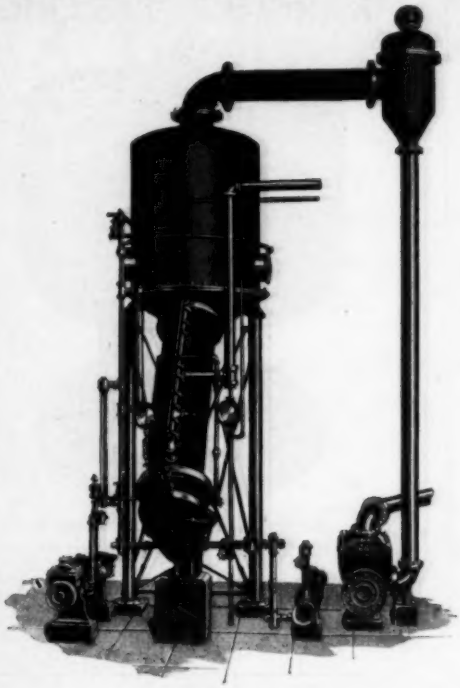

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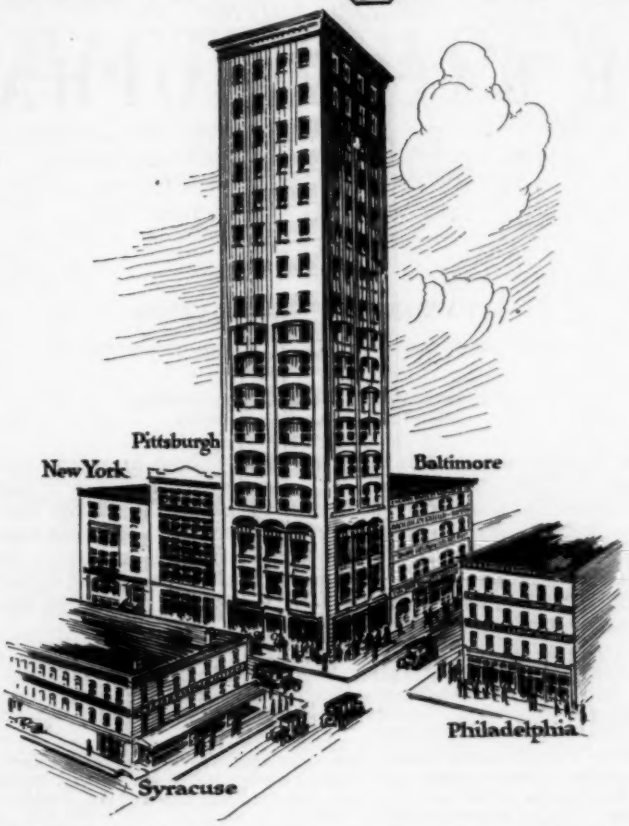

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